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Curriculum Guideline

Science

Intermediate and Senior Divisions

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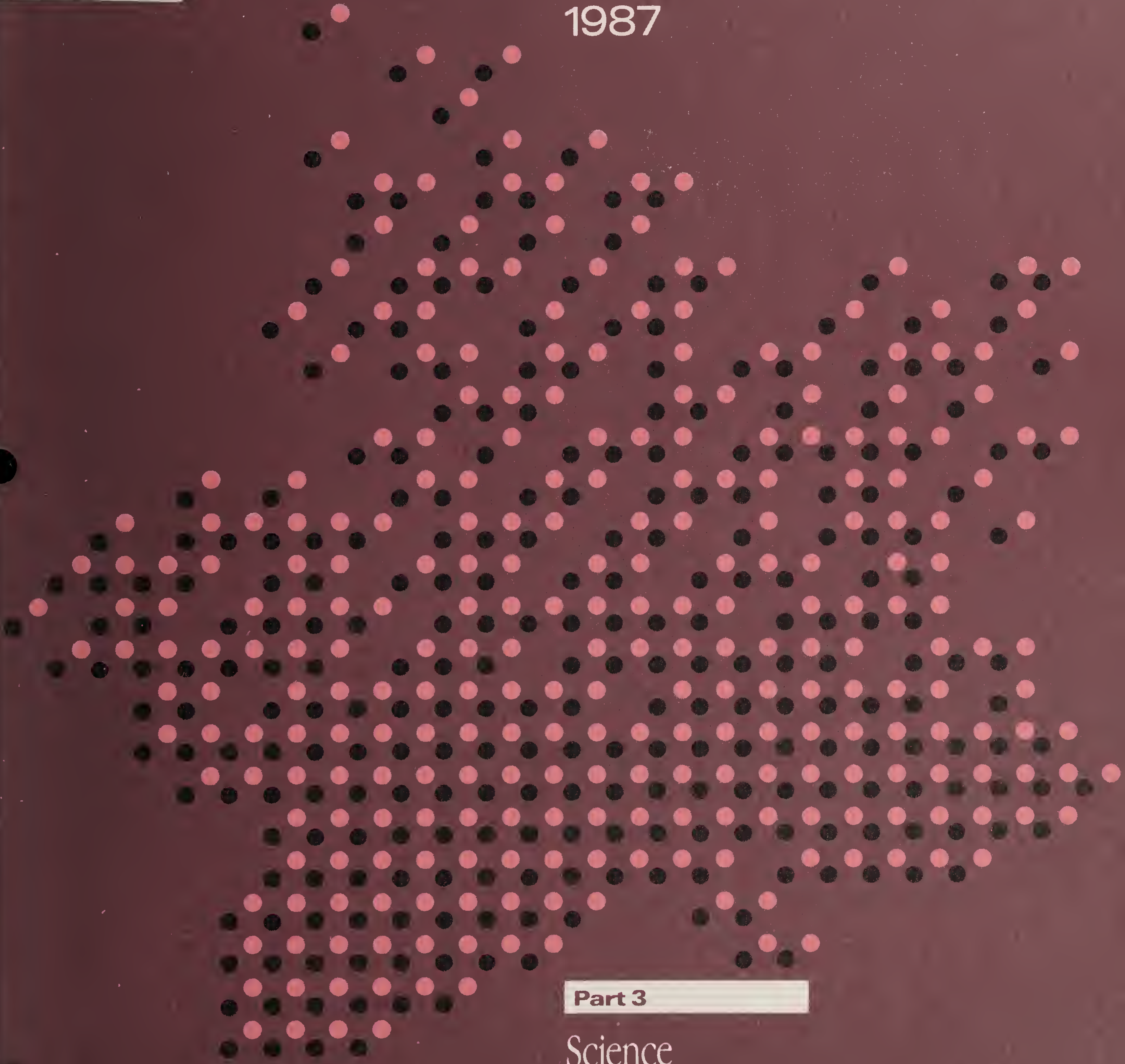

Part 3

Science

Grades 9 and 10, General Level

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Introduction

The Parts of the Guideline

This document is Part 3 of a fifteen-part curriculum guideline that outlines the science program for the Intermediate and Senior Divisions in Ontario schools and describes the science courses that can be offered (see the list of courses and their course codes in Appendix A). The term *guideline* refers to the entire set of fifteen parts.

This part must be read and implemented in conjunction with Part 1, *Program Outline and Policy*. When implementing the courses that are described in this document, teachers are to incorporate the many policies and features outlined in Part 1, which will enable them to interpret the overall intent and expectations of the Ministry of Education in the science program. The table of contents for Part 1 is given in Appendix B at the end of this document so that the reader may have ready access to the list of chapters and topics therein.

The provincial science program for the Intermediate and Senior Divisions comprises the courses described in Parts 2 to 15. These come under the framework and policy set forth in Part 1. The entire science guideline consists of the following fifteen parts:

Part 1: Program Outline and Policy
Part 2: Science, Grades 7 and 8
Part 3: Science, Grades 9 and 10, General Level
Part 4: Science, Grades 9 and 10, Advanced Level
Part 5: Science, Grades 9 and 10, Basic Level
Part 6: Science, Grades 11 and 12, Basic Level
Part 7: Environmental Science, Grades 10 to 12, General Level
Part 8: Environmental Science, Grades 10 and 12, Advanced Level
Part 9: Applied Biology and Applied Chemistry, Grade 11, General Level
Part 10: Applied Physics and Technological Science, Grade 12, General Level
Part 11: Geology, Grade 12, General and Advanced Levels
Part 12: Biology, Grade 11, Advanced Level, and the OAC
Part 13: Chemistry, Grade 11, Advanced Level, and the OAC
Part 14: Physics, Grade 12, Advanced Level, and the OAC
Part 15: Science in Society, OAC

The chart on the next page indicates the twenty-eight science guideline courses that may be offered in Grades 7 to 12 and at the OAC level.

Policies and Features That Apply Across the Science Program

Part 1 of the guideline specifies a great number of the policies and features that are to be integrated into the design of the science program in the Intermediate and Senior Divisions. There are too many of these to describe them in full in each of Parts 2 to 15, but the following points will give the reader some idea of the scope that is involved. They include:

- information about the science credits that are required for the earning of the Ontario Secondary School Diploma;
- a list of science courses that are prerequisite to other science courses;
- the policy regarding mandatory student activities in the science laboratory;
- a list of the aims of the science curriculum and the various emphases that may be used to blend these aims with scientific content;
- policy governing time allocations for units of study and the order in which core and optional units may be taught;
- stipulations about locally designed units;
- suggestions about preferred routes that students might take through the science program in a secondary school;
- recommendations related to exceptional students, individualized instruction, life-management skills, career awareness, the role and evaluation of language in science courses, and a balanced perspective on the role of both girls and boys in science;
- recommendations on the introduction and handling of sensitive issues;
- specific suggestions about resources for the teaching of science;

Authorized Science Guideline Courses, Intermediate and Senior Divisions

Grade 7		Science	
Grade 8		Science	
	Basic Level	**General Level**	**Advanced Level**
Grade 9	Science (SNC1B)	Science (SNC1G)	Science (SNC1A)
Grade 10	Science (SNC2B)	Science (SNC2G) Environmental Science (SEN2G)	Science (SNC2A) Environmental Science (SEN2A)
Grade 11	Science (SNC3B)	Applied Biology (SBA3G) Applied Chemistry (SCA3G) Environmental Science (SEN3G)	Biology (SBI3A) Chemistry (SCH3A)
Grade 12	Science (SNC4B)	Environmental Science (SEN4G) Geology (SGE4G) Applied Physics (SPA4G) Technological Science (STE4G)	Environmental Science (SEN4A) Geology (SGE4A)* Physics (SPH4A)
OACs			Biology (SBI0A) *Prerequisite* – Biology (SBI3A) Chemistry (SCH0A) *Prerequisite* – Chemistry (SCH3A) Physics (SPH0A) *Prerequisite* – Physics (SPH4A) Science in Society (SSO0A) *Prerequisite – One of:* Biology (SBI3A) Chemistry (SCH3A) Environmental Science (SEN4A) Geology (SGE4A)* Physics (SPH4A)

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* Since the Grade 12 advanced-level geology course described in the guideline (see Part 11) may be taught under the aegis of a geography department as Geology (GGE4A) – note the course-code change – then either Geology (SGE4A) or Geology (GGE4A) may count as a prerequisite to Science in Society (SSO0A).

- ideas about different modes of delivering science courses, including the co-operative education mode;
- policy pertaining to the significant role to be played by measurement and metric units in science courses;
- stipulations related to the treatment of symbols, significant digits, and mathematical problem solving;
- recommendations concerning the roles to be played by calculators and computers in science courses;
- specific directions about safety;
- policy and principles pertaining to the evaluation of student achievement;
- policy regarding differences in the treatment of science courses at the three levels of difficulty;
- many suggestions about implementing the science program.

It cannot be emphasized strongly enough that teachers of science must integrate the policy and recommendations outlined in Part 1 with the teaching of science and cannot simply rely on the course descriptions given in Parts 2 to 15 of the guideline.

The Intermediate Division Continuum

The two courses Science, Grade 7 and Science, Grade 8, together with the science program of Grades 9 and 10, form a continuum that is intended to help students see something of the panorama of science, enjoy the subject, and appreciate its application to their lives and to society in general. This four-year continuum should also prepare many students for further studies in science in their Senior years.

During the Intermediate years the program is intended to provide a diversified approach to the science disciplines and to build on the more unified approach that is characteristic of the Primary and Junior years.

The Grade 9 and 10 general-level courses build on the Grade 7 and 8 program and continue to provide students with the opportunity to work for short portions of each course in each of the disciplines: biology, chemistry, physics, and environmental science. This *mosaic* permits variety and diversity, but also allows students to note interrelationships among the sciences. Before the end of Grade 10, students should be able to select those science disciplines in which they wish to specialize in the Senior years.

All teachers of science in the Intermediate years should have some familiarity with the subject matter contained in the science courses that they do not teach so they can minimize overlap among the courses and ensure that continuity is provided.

In the Grade 9 and 10 general-level science courses, the core units and the prescribed number of optional units are to be included. The time allocation for each unit of study should act as a guide in helping teachers devote a proportionate amount of time to each of the units in a course. This is important in view of the continuum from one course to another, and it is essential if students are to be adequately prepared for further studies in science in the Senior Division.

The Grade 7 and 8 science courses, particularly the core units, provide an important preparation for science in Grades 9 and 10, which is usually offered at the basic, general, and advanced levels of difficulty, as well as for environmental science in Grade 10, which may be offered at the general and advanced levels.

Full-Credit Courses in Grades 9 and 10

It is anticipated that most students will take science in Grades 9 and 10, since two science credits are among the compulsory subjects needed to earn the Ontario Secondary School Diploma. In order to retain the mosaic nature of the Intermediate Division science courses (the inclusion of biology, chemistry, physics, and environmental science), each of Science, Grade 9, General Level and Science, Grade 10, General Level is to be offered only as a full-credit course within a single school year or semester. It should be noted that any two science guideline courses may be counted among the compulsory credits required for the diploma. Thus, some students may wish to take environmental science rather than science in Grade 10. (See also subsection 4.3 of Part 1 of the guideline.)

Curriculum Emphases

It is recommended that teachers organize each of the courses described in this document around a particular curriculum emphasis or set of emphases. Such emphases give the curriculum a special focus that can be introduced in addition to the content and processes outlined in the courses. This approach is discussed in subsection 3.4, "Curriculum Emphases – Blending Curriculum Aims With Content", of Part 1 of the science guideline. In table 2 of that subsection a list of emphases is given. These emphases will enhance the development of the science courses described in this document. A particular emphasis that is stressed throughout an entire course or for one or more units at a time needs to be highlighted so that it becomes a focal or integrating theme.

Student Activities

In each unit of study there is a section entitled "Student Activities". This section indicates the *mandatory* laboratory activities required of students. Teachers may substitute *equivalent* laboratory activities where appropriate. Those activities that are actually to be performed by students themselves are marked with asterisks. If time and circumstances permit, the teacher should encourage students to do some or all of the unmarked activities as well. However, such activities may be demonstrated by a student or the teacher or may be discussed in conjunction with a textbook, film, computer program, or other learning material used as a resource. In any event, the scientific concepts and principles related to such unmarked activities and identified in the objectives of the unit of study shall be considered to be part of the prescribed course.

Generally, the best approach to the teaching of science is to ensure that the content develops directly from related student activities. In each unit of study the skills and processes of scientific work should be presented as the central component, from which the subject matter, applications, and implications emerge.

Safety

Safety awareness must be developed in all science students. Constant attention to accident prevention is to be stressed in all student activities and teacher demonstrations in the laboratory. Section 9, "Safety", in Part 1 of the science guideline contains the following comprehensive subsections:

- Safety in the Laboratory
- Some Recommended Safety Procedures
- Animal Care in Science Courses
- The Safe Use of Plants

In each unit of study, subsection 6, "Safety Considerations", acts as a reminder of some of the safety features that pertain to the unit in question. General reference, however, should constantly be made to the safety section in Part 1. Schools must always remain on the alert in regards to safety and maintain an up-to-date safety-awareness program.

Sensitive Issues

The curriculum outlined in this science guideline places a distinct emphasis on the science-technology-society connection. For this reason scientific applications and societal implications are mandatory components of each unit of study. In addition, Part 1 of the guideline underlines the need to incorporate morals/values education in science courses. Undoubtedly, this will give rise to the discussion of some senstive issues. Such discussions are important. Generally, they should be focused and should provide an open forum for the expression of different viewpoints. In this regard teachers of science are urged to familiarize themselves with section 10, "Values in Science Education", of Part 1 of the guideline and to pay particular attention to the principles to be observed when dealing with sensitive issues in the sicence curriculum. These principles are mentioned in subsection 10.2 of Part 1.

Locally Designed Units

Among the optional units in each of the courses described in this document is one entitled "Locally Designed Unit". Such a unit is included to allow teachers, at their own discretion, either to introduce an appropriate new area of science not described in the guideline or to include additional new work that will expand on previous parts of the course.

Evaluation of Student Achievement

In each unit of study described in the courses outlined in this document, subsection 5, "Evaluation of Student Achievement", specifies certain items that must be included in the students' term marks (exclusive of formal examinations) when their achievement is evaluated. In most units teachers are required to evaluate students' activities and related laboratory reports. However, the proportion of the mark assigned will vary from one teacher to another. In order that the experimental component of science be emphasized, the overall mark for an entire science course must include at least 15 per cent for the evaluation of student achievement in laboratory skills and reports.

Cross References

In the descriptions of each unit of study in the courses outlined in this document, cross references are provided in parentheses. These are included to provide some examples of the relationships that exist among the parts of the unit.

Particular Features of the Grade 9 and 10 General-Level Science Courses

Units of Study and Their Time Allocations

The following charts provide an overview of the units of study in Grade 9 and 10 science at the general level. They also indicate the time to be allocated to each unit.

Science, Grade 9, General Level (SNC1G)

Units of Study		Time Allocations
Core		
1. Physical Change		16 h
2. Mixtures		16 h
3. Chemical Change		16 h
4. Cells and Cell Systems		16 h
5. Green Plants		16 h
6. Food and Energy		16 h
		96 h
Optional		
One of:		
1. The Science of Sports and Leisure	14 h	14 h
2. Separation of Substances	14 h	
3. Simple Machines	14 h	
4. Locally Designed Unit	14 h	
		110 h

Science, Grade 10, General Level (SNC2G)

Units of Study		Time Allocations
Core		
1. Community Ecology		16 h
2. The Functioning Animal		16 h
3. Environmental Chemistry		16 h
4. Magnetism and Electricity		16 h
5. The Wise Use of Resources		16 h
		80 h
Optional		
Two of:		
1. Astronomy	15 h	30 h
2. Minerals and Mining	15 h	
3. Continuity	15 h	
4. Metals	15 h	
5. Terrestrial and Aquatic Ecosystems	15 h	
6. Locally Designed Unit	15 h	
		110 h

Balance Over the Two Courses

The eleven core units in these two years, six in Grade 9 and five in Grade 10, provide a balance among biology, chemistry, physics, and environmental science. The selection of an additional three optional units, one in Grade 9 and two in Grade 10, can complement the core units, and they can be tailored to student needs, teacher expertise, and the local context.

Another form of balance that must be planned is that between content and process. While subject matter is important, hands-on experiences must also constitute a major component of these courses. Students should become familiar with many scientific skills prior to further study in the Senior Division. Students' ability in demonstrating such skills should be assessed as part of the evaluative process.

These science courses at the general level relate science to practical, everyday experiences that are familiar to students. The student activities reinforce these practical applications and provide students with the opportunity to develop skills related to problem solving, domestic management, consumer judgement, recreational pursuits, personal fitness, and employment awareness.

Relationships Between the General- and Advanced-Level Courses

These courses at the general level are markedly different from the advanced-level courses in science in Grades 9 and 10. For example, in the general-level courses mathematical concepts are de-emphasized. However, depending largely on their students' ability, some teachers may wish to include more mathematical problem solving than that prescribed. Such additional work should relate science to students' lives and should be considered as optional enrichment to the program.

Although teaching approaches and strategies will differ, it is recommended that similar subject material be used at the beginning of both Grade 9 general-level science and Grade 9 advanced-level science. This can be done through a careful selection of topics from the first three core units of the general-level course and the first two core units of the advanced-level course. In this way, students who are doing exceptionally well in the general-level course after a few weeks may have the opportunity to switch to the advanced-level course without much setback in their work. Similarly, students who are finding it too difficult to cope with the advanced-level course may have the chance to switch to the general-level course, which they may find better suited to their abilities and needs. It should be recognized, however, that as the general- and advanced-level science courses in Grade 9 progress, they will become more divergent in subject matter and academic expectations.

Specific Approaches to Be Considered

In optional unit 1, "The Science of Sports and Leisure", of the general-level Grade 9 science course, the sports component described in this document relates to ball games, and the leisure component to photography. Substitutes for these components may be made by the teacher, who shall then develop objectives and features in his/her unit similar to those described for ball games and photography.

In both the Grade 9 and 10 general-level courses, a field trip is recommended as a student activity. Such field studies provide valuable first-hand experiences for students and should be included in the courses if at all possible. Both courses also require that students use microscopes; although they are costly and require careful maintenance, every effort is to be made to provide students with practice in their use.

The core units of the Grade 10 course focus on the role of the student as a participant in the ecosystem. The life science units consider the individual organism in terms of its needs and the interactions in the biological community required to meet these needs. The physical science units focus on the student's use of some of the non-living components of the ecosystem and the important role played by the student in consuming or depleting these resources. The course also provides students with the opportunity to carry out a simple dissection in core unit 2, "The Functioning Animal". An emphasis should be placed on the appropriate attitudes related to respect for living things and on the skills required to do the dissection successfully.

In Grade 10, core unit 2, "The Functioning Animal", contains some content that may be included in health courses. The major focus of this unit in science should be on the student activities and laboratory work that are not included in the health program. Co-operative planning should take place between health and science teachers to ensure that any overlap is minimal and that the courses are complementary.

In Grade 10, optional unit 1, "Minerals and Mining", contains content that may be included in some geography courses. If this unit is selected, co-operative planning should take place between the science and geography departments to ensure that overlap is avoided and that the courses are complementary.

Metric Units in Grades 9 and 10

Subsection 8.2 of Part 1 of the science guideline contains a list of metric units with which students are expected to be familiar by the end of Grade 10. Teachers of science and mathematics in Grades 9 and 10 should co-ordinate their work to ensure that this objective is achieved, particularly by students who intend to proceed to science courses in the Senior Division.

Science, Grade 9, General Level
(SNC1G)

Core Units

Physical Change
Mixtures
Chemical Change
Cells and Cell Systems
Green Plants
Food and Energy

(96 hours)

Optional Units

The Science of Sports and Leisure
Separation of Substances
Simple Machines
Locally Designed Unit

(14 hours)

Core Unit 1

Physical Change

Time: 16 hours

When substances are exposed to changes in their environment, such as changes in temperature and pressure, their properties and even their states are likely to change. This unit will allow students to observe a wide variety of physical properties in some common substances, to make changes to the environments of those substances, to observe the resulting changes in the properties of each substance, and to make inferences based on their observations.

This unit may be divided into topics such as the following:

- Physical properties
- Changes of state
- The particle theory of matter

1. Objectives

Attitudes. Students will be encouraged to develop:

a) curiosity about the specific physical properties of substances (2a, 2b);
b) a commitment to keep the laboratory clean and tidy in the interests of safety and learning (2).

Skills. Students will have the opportunity to develop skill in:

a) measuring volume, mass, and temperature (2b);
b) describing substances in terms of observed physical properties (2a, 2b);
c) forming a hypothesis as to why ethylene glycol is a better antifreeze than ethanol (2b);
d) organizing and recording data in tabular form (2b).

Knowledge. Students will be expected to:

a) recall that different substances have different physical properties (2a-2e, 8a);
b) list some of the qualitative and quantitative physical properties used to distinguish one substance from another, such as colour, texture, boiling and freezing points, conductivity, and viscosity (2a-2e);
c) recognize that changes of state involve the addition or removal of heat and expansion or contraction (2b);
d) state that the concentration of a solute in a solution may change the boiling and freezing points of the solution (2b);
e) explain that identical volumes of different liquids have different masses because they contain different kinds of particles (2b, 8d);
f) use the particle theory to explain changes in state, expansion and contraction of matter, and diffusion (2b, 8d);
g) name and label on a diagram any apparatus used in an activity (2).

2. Student Activities

Students are to:

*a) describe the physical properties of some unfamiliar substances (6a, 8a);
*b) measure equal volumes of brine, ethanol, water, and a 50 per cent aqueous solution of ethylene glycol into separate beakers; find the mass of each liquid; note the characteristics of each liquid; and complete the following:
  - add an ice cube to each beaker and describe the results;
  - using a thermometer wrapped in an absorbent material, observe the cooling effect of rapid evaporation by each liquid;
  - bring each liquid to the boiling point and measure the temperature;
  - attempt to freeze each liquid;
  - evaporate a small sample of each liquid to dryness in a watch glass;
  - add a crystal of iodine to a petri dish of each liquid;
  - organize the findings in a table, showing the physical properties of each liquid (5c, 6);

c) drop steel or glass spheres into fluid-filled graduated cylinders, observe what happens, and compare the viscosity of a variety of liquids (e.g., oil, brine, water);
d) note the physical changes that occur when water is added to freeze-dried food;
e) investigate changes in temperature when substances (e.g., elastic, a paper clip) are repeatedly stretched or bent.

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* See the subsection entitled "Student Activities" on page 6.

3. Applications

a) Air conditioners and fans use the principle that evaporation causes cooling.
b) Antifreeze is used in car radiators in both summer and winter because it has a low freezing point and a high boiling point.
c) Salt is used on roads in winter to melt ice and snow that are well below the freezing point of water.
d) The expansion of water on freezing can cause pipes to burst, engine blocks to crack, and building foundations and roads to heave.
e) Thermometers are based on the principle that liquids expand when heated and contract when cooled.

4. Societal Implications

a) Frostbite results in damage to the cells of the body as a result of water's expanding in the cells as it freezes.
b) The widespread use of ethylene gylcol as an antifreeze in automobiles allows people to travel in all kinds of weather.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, including the measurement of volume, mass, and temperature;
b) safe handling and care of equipment in the laboratory;
c) organization of experimental data;
d) oral or written communication with the teacher and classmates.

6. Safety Considerations

a) Substances with unknown properties should be handled with care.
b) When flammable materials are heated, caution should be exercised. Flammable materials should not be heated over an open flame.
c) Liquids should be boiled in a beaker, rather than a test tube, to prevent bumping.
d) Alcohol thermometers that read up to 150°C should be used. Mercury thermometers should not be used.
e) Iodine is corrosive and should be manipulated with care. Tweezers or spatulas should be used to transfer the crystals, which must not come in contact with the skin.

7. Possible Extensions

Some students might:

a) investigate the insulating properties of various substances by doing a number of experiments on heat conduction;
b) investigate the electrical conductivity of various liquids;
c) investigate the solubility of potassium permanganate in various liquids.

8. Some Teaching Suggestions

a) This unit can be initiated by having students describe objects in terms of their physical properties. The difference between an observation and an inference should be emphasized.
b) Mathematical concepts should be de-emphasized (e.g., density calculations are not required).
c) In activity 2b students can make hypotheses about the outcomes before attempting the experiments.
d) By measuring mass and volume, students can infer that each substance has particles that are different in size and mass and that there is space between the particles.
e) Students should be evaluated while they are performing the experiments. The organization, safe handling, and care of laboratory equipment should be stressed.
f) The simple aspects of the particle theory of matter should be introduced when explanations of physical phenomena are needed. The diffusion of iodine or potassium permanganate in solution could serve as a simple introduction to the theory.

Core Unit 2

Mixtures

Time: 16 hours

Many of the substances that we encounter in everyday life are mixtures, including those used in food, cosmetics, medicines, industry, and agriculture. These mixtures have many beneficial uses, although some, when misused, can cause environmental damage and other kinds of harm. In this unit students will begin to study mixtures by classifying them according to particle size, for example, as heterogeneous mixtures (mechanical mixtures), homogeneous mixtures (solutions), and colloids. During this study the everyday uses of mixtures will be emphasized.

This unit may be divided into topics such as the following:

- Mechanical mixtures
- Solutions
- Colloids
- Mechanical separation of mixtures

1. Objectives

Attitudes. Students will be encouraged to develop:

a) curiosity about the uses of mixtures in everyday life (3);
b) a commitment to read labels carefully, follow instructions, and use substances wisely (2c);
c) self-confidence by successfully completing assigned tasks and reporting the results to their teacher and classmates (2);
d) a healthy respect for the properties of unknown substances and for the possible effects of these substances on people and the environment (4).

Skills. Students will have the opportunity to develop skill in:

a) describing and comparing mixtures in terms of observed physical properties (2a);
b) classifying mixtures into various types on the basis of observed properties (2a);
c) measuring the mass or volume of solutes and solvents to give some indication of the concentration of a solution (2d);
d) using a hand lens (2a);
e) predicting the effects of bleaches of different concentrations on fabrics and testing their predictions (2b);
f) working in groups (2);
g) growing crystals from a supersaturated solution (2d);
h) tabulating the results of experiments (2).

Knowledge. Students will be expected to:

a) list some characteristics of mixtures (2a);
b) recall the meaning of the following terms: solution, mechanical mixture, solute, solvent (8d);
c) describe the meaning of the following terms: colloid, heterogeneous, homogeneous (8d);
d) apply their knowledge of the properties of a selected mixture (e.g., salt and water) to their everyday experiences (3);
e) compare the properties of unsaturated, saturated, and supersaturated solutions (2d);
f) explain why some particles pass through a given surface and others do not (2a);
g) recognize that some materials dissolve more readily in a given liquid than others (2c);
h) describe how two or more components of a mixture can be kept in suspension by the use of emulsifiers and coagulants (2f, 8h);
i) cite methods by which the solute and solvent can be separated in a solution (2g).

2. Student Activities

Students are to:

*a) compare tap water to aqueous mixtures containing substances such as glucose, clay, starch, white beans, and calcium hydroxide by (i) using a hand lens in order to describe the physical properties before and after preparing the mixtures; (ii) filtering each mixture, observing the filtrate and filter paper with a hand lens, and describing their observations; (iii) using distilled water as a control and testing each of the filtrates with bromthymol blue, iodine, and bubbled carbon dioxide; (iv) drawing up a data table to organize their observations (5b);

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* See the subsection entitled "Student Activities" on page 6.

b) test the effect of a concentrated solution of household bleach on various fabrics such as denim (6b, 6c);
c) read the labels of some common household solutions, note any precautions for their use and storage, and then discuss the effect on the environment of the large-scale use of the solutions;
*d) prepare a supersaturated solution, compare its properties to those of unsaturated and saturated solutions, and then use a seed crystal to grow crystals from the supersaturated solution (8d, 8f);
*e) make stains on fabrics with a variety of substances, try to remove the stains with a variety of solvents, and compare the results (6a, 6b);
f) investigate the effect of adding a few drops of soap to an oil and water mixture (8h);
g) investigate methods of separating the components of a solution of potassium nitrate (e.g., evaporation, crystallization and subsequent filtration).

3. Applications

a) Many food products are mixtures (e.g., carbonated beverages, dairy products, salad dressings).
b) Mixtures such as paints, cosmetics, fungicides, herbicides, and pesticides are commodities produced by chemical industries.

4. Societal Implications

a) Mixtures that pollute our drinking water are often not completely removed by water treatment, and in many cases their long-term effects on humans and the environment are unknown.
b) Mixtures such as paints and various preservatives inhibit deterioration and thus reduce costly waste in our society.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, including the description and classification of various mixtures;
b) tabulated results of experimental work;
c) co-operation with other students and completion of assigned tasks.

6. Safety Considerations

a) Care should be exercised in working with any volatile or flammable substance.
b) The laboratory should be properly ventilated when work involves substances that give off noxious fumes (e.g., concentrated bleach solutions).
c) Concentrated bleach solutions should be handled with appropriate caution.

7. Possible Extensions

Some students might:

a) compare the properties of some common mixtures that are found in the home (e.g., milk, salad dressing, ketchup);
b) make a commonly used mixture (e.g., mayonnaise, hand cream).

8. Some Teaching Suggestions

a) Student activity 2a can be used as the basis for the unit. The activity can be done all at once and referred to during the unit, or it can be integrated throughout the unit.
b) Distilled water should be used as a control in activity 2a. The concept of a control should be introduced, and the importance of using controls in experiments should be stressed.
c) Students should do some of the experiments in groups and report their findings to the rest of the class.
d) Students' observations should be used to develop concepts related to the particle size of mechanical mixtures, solutions, and colloids. Students should be encouraged to use the preceding terms as well as terms such as *suspension*, *emulsion*, *emulsifier*, and *coagulant*, but formal definitions are not required.
e) It should be emphasized that some of the physical properties of a solution differ from those of its components (e.g., boiling and freezing points).
f) The growth of crystals in nature should be related to activity 2d.
g) The importance of filtration in everyday devices (e.g., furnaces, vacuum cleaners, cars) should be stressed.
h) Students should be aware that the production of many useful colloids and emulsions (e.g., margarine, some cosmetics) is made possible by the addition of an emulsifier, which makes the droplets of a mixture smaller. Without an emulsifier, the denser particles would fall to the bottom and the less dense particles would rise to the surface.

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* See the subsection entitled "Student Activities" on page 6.

Core Unit 3

Chemical Change

Time: 16 hours

Chemical change is an integral part of our lives and the basis of many everyday events. In the years since the Second World War, thousands of new chemical compounds have been invented by scientists; used in industry, agriculture, medicine, and the home; and released into the environment. By studying various chemical changes, students will learn that in a chemical change there is a rearrangement of the basic particles, namely, the elements.

This unit may be divided into topics such as the following:

- Chemical changes
- Elements and compounds
- Equations
- Chemical properties of gases
- Oxidation and combustion of fuel
- The particle model of matter

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a sense of responsibility for completing assigned tasks, either alone or in a group;
b) an appreciation of the importance of being careful when doing laboratory work and of maintaining a neat and safe workplace;
c) a respect for safety rules when doing laboratory work;
d) curiosity about the causes of phenomena that they observe in experiments and activities.

Skills. Students will have the opportunity to develop skill in:

a) using a beaker or graduated cylinder to measure the volume of liquids;
b) dispensing, handling, and disposing of chemicals safely (2);
c) heating liquids and operating a Bunsen burner safely and correctly (2c, 2i);
d) assembling apparatus from written instructions;
e) testing for oxygen, carbon dioxide, hydrogen, and water (2b);
f) distinguishing inferences from observations;
g) classifying changes as physical or chemical (2a);
h) classifying several substances as elements, compounds, or mixtures on the basis of their observed properties (2);
i) writing word equations for some simple chemical reactions (8b).

Knowledge. Students will be expected to:

a) describe chemical changes in terms of the particle model;
b) distinguish between elements and compounds;
c) explain that, when elements are rearranged to form a new substance, the new substance has different properties from the original ones;
d) describe methods of producing and testing for oxygen, carbon dioxide, hydrogen, and water (2b);
e) list some chemical properties of carbon dioxide, oxygen, and hydrogen (2a-2g);
f) identify and describe the products of combustion (2c);
g) write a word equation containing an energy term for a simple chemical change (8b);
h) list two or three of the main points of the particle model of matter.

2. Student Activities

Students are to:

a) observe some common changes in substances and classify each change as physical or chemical (8a, 8d);
*b) do chemical tests for the presence of carbon dioxide, oxygen, water, and hydrogen (6);
*c) test for the products (carbon dioxide and water) in the combustion of at least one fuel, such as ethanol, natural gas, or wax (3a, 6a, 6b, 8b-8d);
d) observe the rusting of iron filings or steel wool in a suitable container in order to infer the proportion of oxygen in the air (4c, 8b-8d);
*e) decompose hydrogen peroxide (using a catalyst) or water (by electrolysis) and identify the products (4b, 8b-8d);

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* See the subsection entitled "Student Activities" on page 6.

f) investigate the changes that occur when baking soda is combined with vinegar or lemon juice and describe some properties of carbon dioxide (3b, 8b-8d);

*g) observe the reaction of calcium metal with water and describe some properties of hydrogen (6d, 8b-8d);

h) investigate the action of a bleaching agent (e.g., hydrogen peroxide, household bleach) on a sample of hair (3c, 8b-8d);

i) separate a metal from its ore by heating it strongly, using, for example, copper (II) oxide mixed with carbon powder (6, 8b-8d).

3. Applications

a) The combustion of gasoline in a car produces new chemical compounds, including water, carbon monoxide, and carbon dioxide.

b) When baking soda is combined with an acid in baking, the carbon dioxide that is produced causes the product to rise.

c) The bleaching of clothes with household bleach or hydrogen peroxide is a chemical reaction.

d) Substances in the cells of green plants and animals produce energy through chemical reactions.

4. Societal Implications

a) Many consumer products (e.g., plastics) have been artificially created by chemical changes. Although the chemical stability of many of these products makes them extremely useful, they present a disposal problem for society.

b) Hydrogen produced by the decomposition of water may prove to be a new source of energy.

c) The rusting of cars, which is an unwanted chemical reaction, costs society large amounts of money. New products are being developed that will inhibit and prevent rusting.

d) It is postulated that the large amounts of carbon dioxide produced by the burning of fuel may change the world's climate in the future.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, including testing for carbon dioxide, oxygen, hydrogen, and water;

b) notes and records of experiments, including observations of chemical changes;

c) safe handling of equipment and chemicals.

6. Safety Considerations

a) Students should wear appropriate protective eyewear when heating or pouring chemicals.

b) Appropriate ventilation should be provided for any activities or demonstrations that produce noxious fumes.

c) Chemicals should be disposed of in a non-polluting way.

d) Open flames should be kept away from the calcium-water reaction.

7. Possible Extensions

Some students might:

a) investigate the law of conservation of mass by measuring the mass of the reactants and products in a closed system;

b) measure the mass of the steel wool before and after the reaction in student activity 2d to demonstrate the gain in mass of a metal during oxidation;

c) observe the displacement of a metal from a solution (e.g., an iron nail in a copper sulphate solution) and write an equation as a hypothesis to explain the reaction;

d) make a list of reactive chemicals in their homes, describe the proper method of storing each chemical, and make warning posters for use near the storage places.

8. Some Teaching Suggestions

a) Students should be encouraged to describe common situations in which chemical changes occur.

b) Students should write some word equations to represent chemical changes. The memorization of such equations is not required.

c) Students should be encouraged to use diagrams to report and explain their findings.

d) During the student activities, students should be encouraged to report the physical properties of the various substances in as much detail as possible.

e) As an introduction to chemical change, students could be asked to describe what they do to protect the articles they value from unwanted chemical changes.

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* See the subsection entitled "Student Activities" on page 6.

Core Unit 4

Cells and Cell Systems

Time: 16 hours

The cell is recognized as the basic unit of life. Although living things appear in diverse forms, their basic organizational units have many similarities in both structure and function. Cells respond to environmental stimuli and utilize energy to manufacture and transport materials for growth and reproduction. In multicellular organisms, cells are programmed to form groups of cells that function together (e.g., tissues, organs, systems). From a study of the cell, the student will gain an insight into how complex organisms such as humans share common biological features with paramecia and pine trees.

This unit may be divided into topics such as the following:

- Using the microscope
- The cell model
- Effects of environmental change on cells
- Moving materials into and out of cells
- Cell reproduction
- Relationships among cells, tissues, organs, systems, and organisms

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a respect for expensive equipment, such as the microscope (2a, 2d, 2f-2h);
b) objectivity in using the microscope to examine cells (2d);
c) an interest in the many diverse types of cells (2b, 2g, 2h).

Skills. Students will have the opportunity to develop skill in:

a) handling and using the microscope with proper care (2a, 2d, 2f-2h);
b) observing prepared slides at different magnifications (2a, 2f);
c) using a simple method of calibration (e.g., a plastic ruler) to measure the size of the field of view at different magnifications (2a);
d) preparing wet-mount slides of a variety of cells, tissues, and unicellular organisms (2b, 2g);
e) observing wet-mount slides and, where possible, identifying structural features such as the cell wall, cell membrane, cytoplasm, vacuole, chloroplast, and nucleus (2b, 2h).

Knowledge. Students will be expected to:

a) identify the major parts and functions of the compound microscope (2a, 8a);
b) state the main ideas contained in the cell theory;
c) identify the basic parts of the cell, including the mitochondrion, and state the function of each part (2c);
d) describe how unicellular organisms such as paramecia react to environmental change, such as temperature change or increased acidity or salinity (2d);
e) explain how materials enter and leave a cell and explain why this process is necessary (2d, 2e, 8c);
f) describe the major events of mitosis and state what is accomplished by the process (2f, 8d);
g) give examples of the way in which cells of multicellular organisms work together to form tissues, organs, and systems (2h).

2. Student Activities

Students are to:

*a) measure the field of view of a microscope and use the microscope to examine prepared slides (5a);
*b) prepare wet-mount slides of both unstained and stained samples of plant and animal cells and tissues, such as onion or tomato skin, cheek epithelium, leaves of plants such as elodea or lettuce, or protists from pure cultures or hay infusions (6);
c) construct a three-dimensional model of a generalized cell;
*d) subject one or more of the slides prepared in activity 2b to environmental changes by, for example, increasing or decreasing heat or light or adding substances (e.g., alcohol, salt, sugar, distilled water, or acid) and then identify, by observation through the microscope, the changes that occur in the cells (3c, 5b, 6c);

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* See the subsection entitled "Student Activities" on page 6.

e) use dialysis tubing to investigate diffusion through a semipermeable membrane (8c);
*f) examine prepared microscope slides that illustrate the process of mitosis;
g) examine wet-mount slides of protists such as paramecia and add stained yeast cells to note the role of cilia in the feeding process (6c);
h) examine several prepared slides of plant or animal tissue to note the variety of shapes and sizes of cells in the tissue.

3. Applications

a) Microscopes and hand lenses can be used to examine materials in the home and at work (e.g., by a jeweller or a minerologist).
b) Dialysis membranes are used in kidney machines to remove harmful substances from the blood.
c) Foreign substances change a cell's environment and thus may alter the functioning of the cell.
d) Cell replication is normally a controlled process; however, sometimes as a result of changes in the cells' programming, the cells replicate in an uncontrolled fashion, forming cancerous growths.

4. Societal Implications

a) Drastic changes in the environment of living cells (e.g., acid rain, radiation, toxic chemicals) can cause cells to die, which could result in the death of the organism.
b) Living organisms have the ability to adapt to small changes in their external environment.
c) With the release into the environment of thousands of new chemicals, the environment of many plant and animal cells has been greatly altered.
d) The environment of human cells is affected by additives in drinking water and food and by the intake of drugs.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, including the demonstrated ability to prepare and use a microscope to observe a wet-mount slide;
b) records of observations of cells viewed through a microscope.

6. Safety Considerations

a) Students should be warned about the effects of biological stains on the skin and clothing.
b) Single-edged razor blades housed in appropriate holders should be used for cutting tissues.
c) Cleanliness should be emphasized in the handling of cultures of living organisms. Hands, pens, and other objects should be kept out of the mouth.
d) The inner surface of the mouth should be scraped gently with a toothpick or splint in order to obtain cheek cells.

7. Possible Extensions

Some students might:

a) examine a sample of pond water to observe the variety of organisms it contains;
b) examine prepared slides of human tissue that show the effects of environmental stresses (e.g., the effect of nicotine);
c) extend the experiment on living cells to include other environmental factors not already covered (e.g., low or high pH).

8. Some Teaching Suggestions

a) When first using the microscope, the student can write the letter *e* as small as possible, place it on a microscope slide, and then observe the inverted nature of the image formed by the microscope.
b) The jump from the two-dimensional cells viewed under the microscope to the three-dimensional nature of cells can be enhanced by having students look at photographs taken by scanning electron microscopes.
c) Volume changes can be clearly shown in diffusion experiments by means of an osmometer, which can be constructed by inserting a piece of glass tubing into a dialysis membrane bag that contains a sugar or molasses solution. The resultant volume changes would help the teacher or student to develop the model of diffusion through membranes.
d) Onions placed so that only their roots are immersed in water can provide many root tips, which can then be crushed and stained with aceto-orcein to demonstrate mitosis.

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* See the subsection entitled "Student Activities" on page 6.

Core Unit 5

Green Plants

Time: 16 hours

Without green plants there could be no human or animal life. Plants supply us with food, clothing, shelter, medicine, fuel, paper, animal feed, and oxygen. In this unit students will become aware of how dependent they are on plants and will learn to apply their knowledge of cell metabolism to a study of photosynthesis.

This unit may be divided into topics such as the following:

- Uses of plant products
- Plants in the ecosystem
- Photosynthesis
- Absorption and conduction in plants
- Leaves, stems, and roots
- Plant adaptations

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a respect for the role of green plants in the maintenance of life on earth (3a-3c, 4b-4e);
b) an appreciation of the variety of ways in which plants have been and are used by people (3d);
c) a concern for the effect that people's living habits have on plant life (4c, 4d).

Skills. Students will have the opportunity to develop skill in:

a) testing plant material for starch (2a, 2b, 2h);
b) germinating seeds (2g);
c) using a microscope to observe prepared slides of cross sections of a leaf (2f).

Knowledge. Students will be expected to:

a) know the word equation for photosynthesis (2a-2c);
b) describe the importance of photosynthesis to animal life (3a);
c) list at least eight uses of green plants in their lives (3d);
d) state what a green plant needs in order to grow and propagate;
e) describe how the structure of the leaf, stem, and root relates to their function in photosynthesis;
f) explain how water is absorbed by the roots of plants and transferred to the site of photosynthesis (2d);
g) list some ways in which plants have adapted to their environments.

2. Student Activities

Students are to:

*a) grow plants with and without light and test for starch production after removal of leaf pigments (6a);
*b) use a coleus or other similar variegated plant to show that chlorophyll is needed for photosynthesis by testing for starch after removal of leaf pigments (6a);
c) do an experiment using aquatic plants to show that oxygen is given off and carbon dioxide consumed during photosynthesis;
d) using water-soluble dyes or food colouring, do an experiment to demonstrate the absorption of water by germinating radishes or grass seedlings and show that the vascular system extends from the roots to the leaves;
e) do an experiment to compare the rates at which water is conducted through celery stalks with and without leaves;
*f) locate and identify chloroplasts in the cells of a leaf by observing a prepared slide of a cross section of a leaf under high magnification;
*g) germinate seeds of such plants as radishes on paper towels moistened with solutions of varying pH to investigate the relationship of plant growth to pH;
h) test the endosperm of the cotyledons of bean seeds for the presence of starch and then germinate bean seeds and test for the presence of starch in the cotyledons after the development of the primary leaves (6a).

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* See the subsection entitled "Student Activities" on page 6.

3. Applications

a) Green plants are the primary source of food for all animals.
b) Farmers and gardeners use a knowledge of the requirements for plant growth to grow plants successfully.
c) Natural and synthetic fertilizers are applied to the soil in order to ensure that plants will have the necessary nutrients for growth.
d) Plants and plant derivatives provide a vast number of useful products. (*Note:* Students should make a list of these, including some from the past that are now rarely or no longer in use.)
e) Crop rotation is used to help maintain the quality of the soil.

4. Societal Implications

a) A knowledge of and interest in green plants may lead to a career in agriculture, the agri-food business, horticulture, or landscaping.
b) Plants are the basis of much of the Canadian economy, including wheat farming and the forest industry.
c) The growth of trees in many parts of the world is being harmed by acid rain.
d) The use of wood for fuel has led to deforestation in some countries. Trees are a renewable resource that requires proper management.
e) A large number of Canadians find pleasure in growing house plants.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, including a demonstration of the fact that green plants require light in order to produce starch;
b) science notes and records of experiments.

6. Safety Considerations

a) A hot plate and water bath should be used in heating alcohol to extract chlorophyll from leaves. Methanol should not be used. Appropriate ventilation should be provided when this activity is carried out.
b) Teachers should ask students to report to them if they have any allergies to plant material.
c) Hands should be washed after handling soil, plants, or chemicals.

7. Possible Extensions

Some students might:

a) propagate and grow some common house plants;
b) compare the effect of different media on the development of plant cuttings;
c) experiment with the effect of light of different colours on photosynthesis;
d) grow plants, using hydroponic techniques.

8. Some Teaching Suggestions

a) The leaf can be compared to a factory, as illustrated in the following table:

Plant	Factory
xylem and stoma	reception areas
water, minerals, and carbon dioxide	raw materials
green cells (+ chlorophyll)	workrooms where the product is produced
chloroplasts and enzymes	machinery
light	energy intake (electricity, oil, gas)
sugar-starch chain	main product
oxygen	by-product
phloem and stoma	shipping

b) Students should be encouraged to ask older members of their families about traditional medicinal remedies from plants and report these to the class.
c) Students can read newspaper articles about plants threatened with extinction and the need for parks and conservation areas.
d) Students can visit a greenhouse, or a florist or greenhouse owner or manager could be invited to address the class. A job description for each employee in a greenhouse could also be obtained.
e) Common diseases of house plants and the treatment required to control them can be discussed.

Core Unit 6

Food and Energy

Time: 16 hours

Today few people produce their own food, and in most cases the food is produced a long way from where it is consumed. Everyone has a very personal stake in where their food is produced, how it affects the land where it is grown, and its final quality when it reaches the table. Scientific principles are involved in each step of the food-production process. This unit will focus on these principles and the role of plants as the basic food source for humans. Although this unit deals primarily with foods derived from plants, some reference is made to foods that are derived from animals.

This unit may be divided into topics such as the following:

- Plants as a source of food
- Plant propagation
- Plant diseases
- Food production and processing
- The energy and nutrient content of foods

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an interest in the wide range of plants used for food (2a);
b) curiosity about the methods used to process foods (3a-3c);
c) an appreciation for the role of science in each step of food production and processing.

Skills. Students will have the opportunity to develop skill in:

a) observing and describing examples of plants that are used for food (2a);
b) comparing varieties of the same plant food (2c);
c) designing an experiment to estimate the energy content of one kind of food (2d);
d) collecting and tabulating data on the energy content of various foods (2d);
e) classifying foods according to the parts of the plants from which they are derived (2a).

Knowledge. Students will be expected to:

a) name ten plants that are commonly used for food by humans;
b) identify the parts of plants used for food and give examples of food from each part (2a, 8b);
c) outline methods by which new plants are started in the field (e.g., seed potato, seedlings, seed);
d) recall the requirements for plant growth and describe ways in which these requirements may be supplied (e.g., fertilizer, irrigation);
e) describe some typical plant diseases (e.g., apple scab, wheat rust) and outline ways in which they may be controlled (3d, 8b);
f) trace the path of some foods (at least one plant food and one animal food) from the field to the table and indicate the energy inputs required at each step (8);
g) describe the important qualities of a food sample that is ready for consumption (e.g., taste, colour, storage ability);
h) compare the energy content of several common foods (2d);
i) name and briefly describe the major chemical constituents of foods, both plant and animal, such as carbohydrates, proteins, lipids, water, vitamins, and minerals (5c).

2. Student Activities

Students are to:

*a) observe and describe examples of food taken from different parts of a plant (5c, 6a);
b) collect samples of plant material showing disease and describe the effects of the disease (6a);
*c) compare the physical characteristics of several varieties of the same plant food, such as apples (6a);
*d) design and carry out an experiment that gives a rough estimate of the amount of energy in a peanut and then compare its approximate energy content with that of several other food samples (5a, 6b, 8e);
e) use simple chemical tests to identify the presence of sugars, starch, and fat in food samples (5c, 6a).

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* See the subsection entitled "Student Activities" on page 6.

3. Applications

a) Modern farming requires a knowledge of sophisticated techniques that are based on scientific principles.
b) The number of steps involved in processing a food is reflected in the price of the food.
c) Breeding techniques are used to develop plants and animals that produce high-quality food products.
d) Various chemicals are used to control plant and animal diseases and as a result improve the quality of food products.

4. Societal Implications

a) A wide range of careers exists in the food business.
b) The removal of good agricultural land for urban development may result in the need to import certain foods.
c) The use of chemicals improves crop production but may leave residues in the soil that could contaminate water supplies.
d) Health is influenced by diets, and diets can be balanced through a knowledge of the components (and their functions) of foods derived from plants and animals.

5. Evaluation of Students

At least 50 per cent of the term mark for this unit is to be based on students':

a) designing an experiment to estimate the energy content of a food;
b) collecting and tabulating data from experiments;
c) classifying foods according to their sources and identifying their components.

6. Safety Considerations

a) Students should wash their hands after handling plant materials.
b) Students should wear appropriate protective eyewear when heating food samples.

7. Possible Extensions

Some students might:

a) determine the vitamin C content of various samples of orange drinks;
b) investigate the mineral content of several food samples;
c) investigate the effects of air pollution on the quality of food products;
d) determine the types of commercial products made from a particular plant food (e.g., tomatoes, peanuts).

8. Some Teaching Suggestions

a) This unit should focus on the application of scientific principles to the various stages of the food-production process.
b) A comparison of different plant foods (e.g., tomatoes and potatoes) can form the focus of the unit. The following items can be considered: the part of the plant used, how the plant is propagated, diseases affecting the plant, how the plant is harvested, how the plant is processed.
c) A visit to a farm, an agricultural fair, or an institution that offers agricultural programs, such as the University of Guelph, a horticultural school, or a college of agricultural technology, would enhance this unit.
d) The publication *Helpful Teaching Resources for Food Systems and Agriculture*, produced by the Ontario Ministry of Agriculture and Food, contains lists of excellent resources for this unit. The Ontario Ministry of Education publication *Energy in Society: A Resource Guide for Teachers* contains many useful ideas and activities (see Part 5, "Food").
e) In activity 2d students can obtain a rough estimate of a peanut's energy by noting the temperature increase in 50 g of water when it is heated by the burning of the peanut(s). Other food samples that can be burned are cereals and dried foods. Equal masses of food samples should be used.

Optional Unit 1

The Science of Sports and Leisure

Time: 14 hours

Scientific principles are the basis of many sports and hobbies. An understanding of some of these principles may give students greater pleasure in their leisure-time activities. This unit will focus on ball sports and activities that involve photography. Any sport or leisure activity that is of personal or local interest may be substituted; however, if this is done, the teacher must develop appropriate components that are similar to those outlined for this unit.

This unit may be divided into topics such as the following:

- Simple motion
- Motion through fluids
- Ball sports
- The pinhole camera
- Lenses
- The modern camera

1. Objectives

Attitudes. Students will be encouraged to develop:

a) curiosity in the application of science to sports and leisure activities (3);
b) an appreciation of how an involvement in sports and hobbies can be a means of developing good physical fitness and mental health (4).

Skills. Students will have the opportunity to develop skill in:

a) determining the average speeds of various balls used in sports (2a);
b) measuring and comparing the bouncing ability of different balls (2a);
c) observing the effects of air jets on balls (2b);
d) observing the effects of spin on a ball (2b);
e) inferring the effects of different-size pinholes on the image quality produced by a pinhole camera (2c);
f) drawing ray diagrams to show how an image is formed by a pinhole camera (2c);
g) determining the focal length of a convex lens (2c);
h) observing and recording the sizes of real images produced by a convex lens at various positions from an illuminated object (2c).

Knowledge. Students will be expected to:

a) describe the meaning of the following terms: speed, average speed, terminal speed, backspin, topspin, acceleration, drag, air resistance (2a, 2b);
b) explain that an object may be accelerated by a single force;
c) explain that the motion of a ball is affected by spins and air resistance (2b);
d) describe the effects of air jets on balls (2b);
e) explain how a spin on a ball can enhance a sport (8a);
f) give evidence that light travels in straight lines (2c);
g) describe with the aid of ray diagrams how a pinhole camera forms an image (2c);
h) identify characteristics of convex lenses and describe the images formed by such a lens on a screen or on photographic film (2c, 2d);
i) compare the human eye to a camera;
j) identify the main parts of a modern camera.

2. Student Activities

Students are to:

*a) measure either (i) the average speeds of various balls rolling across the floor or moving through the air or (ii) the heights to which various balls can bounce when dropped from a given height. They are then to tabulate their results;
*b) investigate the effect of (i) an air jet on a light ball (e.g., ping-pong ball, styrofoam ball) first when the ball is dropped into a vertical jet of air and then when the air jet is inclined away from the vertical; *or* (ii) blowing air between two light balls that are suspended by threads and are a slight distance apart; *or* (iii) dropping a ball, first with no spin, then with topspin, and finally with backspin. Students should record their observations and explanations;
*c) investigate either (i) a pinhole camera and the images formed by it when the distance from the pinhole to the image screen is altered and when the size of the pinhole is made to vary

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* See the subsection entitled "Student Activities" on page 6.

or (ii) a convex lens by measuring its focal length and by forming images of nearby illuminated objects and describing the characteristics of the images formed (6, 8b);

d) set up an optical bench, a convex lens, and an illuminated object; they are then, for various object positions, to compare the size of the image produced on a screen with the actual size of the object, as well as the image distance with the object distance (6);

e) do a library search on either the science of a ball sport such as baseball or table tennis or some aspect of modern photography.

3. Applications

a) A scientific approach to sporting events has provided valuable information that has been used in developing coaching and training strategies (e.g., radar guns are used to determine the speeds at which baseballs travel, and photographic techniques are used to analyse their trajectories).

b) A knowledge of how a simple camera functions is essential in understanding how modern conventional cameras, television cameras, and video cameras operate.

c) Career possibilities exist in the design, operation, maintenance, repair, and sales of athletic and optical equipment.

4. Societal Implications

a) Scientifically designed sports equipment (e.g., hockey helmets and face shields) has increased the safety aspects of many sports.

b) Photography is a leisure activity that many people enjoy.

c) The participation in various types of ball sports contributes to the welfare of many people.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) performance during laboratory work;

b) records of observations and measurements.

6. Safety Considerations

If a luminous flame is used as a light source, loose clothing and hair must be tied back.

7. Possible Extensions

Some students might:

a) use a Polaroid camera to investigate the effect of exposure times on the quality of a photograph;

b) investigate the scientific implications of a sport or leisure activity in which they have not participated but in which they may have a potential interest;

c) initiate a new school club to focus on a particular sport or leisure activity;

d) interview people in the community who may be knowledgeable about the scientific aspects of a sport or leisure activity.

8. Some Teaching Suggestions

a) When students are performing activity 2b(iii), an attacking shot (topspin) and a defensive shot (backspin) can be demonstrated by means of a ping-pong ball and a paddle. Examples can be given of how spin is used effectively in such sports as baseball, basketball, tennis, bowling, and billiards.

b) An adjustable viewing screen and pinhole should be available for activity 2c(i).

c) Guest speakers could be invited to discuss modern photography or a sport related to this unit with the class.

Optional Unit 2

Separation of Substances

Time: 14 hours

Substances that are free from impurities are important in our daily lives. For example, water that is free of contaminants is essential for human life. Methods have been developed to remove many of the contaminants from water to make it safe to drink. This unit will focus on the various methods of purifying substances, that is, of separating one substance from another.

This unit may be divided into topics such as the following:

- Filtration
- Distillation
- Sedimentation and floc formation
- Purifying air and water

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a commitment to help maintain our natural resources, in particular water and air (4);
b) an inquisitive attitude about the techniques used for separating substances that we use in our daily lives (3).

Skills. Students will have the opportunity to develop skill in:

a) safely performing separation procedures (e.g., filtration, simple and fractional distillation, sedimentation, floc formation);
b) using appropriate equipment to separate two liquids that form a solution (2d);
c) observing the effect of floc formation on sedimentation (2f);
d) inferring whether filtration will separate all mixtures (2a, 2b).

Knowledge. Students will be expected to:

a) define or use the following terms: filtrate, residue, distillate, distillation fraction, fractional distillation, sedimentation, floc formation;
b) describe the effect of filtration on solutions and suspensions (2a);
c) use the particle theory to explain filtration and rate of sedimentation (2a, 2e, 2f);
d) select a suitable procedure for separating the components of an unknown mixture;
e) describe how a bubble tower (students should be provided with a diagram of one) is used to separate petroleum into kerosene, gasoline, and other fractions;
f) explain the practical application and importance of filtration and distillation (3a, 3b).

2. Student Activities

Students are to:

*a) filter several mixtures, including some that appear to be "pure" (e.g., homogenized milk, salad dressing, oil, copper sulphate solution); examine the residues and filtrates; and then infer whether filtration will separate all mixtures (6a);
b) filter "pure" tap water and examine any residue and then evaporate a sample of "pure" tap water and examine the residue;
*c) compare the effects of simple distillation on solutions and suspensions, such as a copper sulphate solution or a clay-and-water suspension (6c, 6d, 8d);
d) separate a mixture of two liquids, such as alcohol and water (6, 8f);
e) observe the effect of particle size on the rate of sedimentation, using various sizes of plastic beads and a suspension of soil and water (6a, 8g);
*f) observe the effect of floc formation on the sedimentation of a suspension (6a).

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* See the subsection entitled "Student Activities" on page 6.

3. Applications

a) Filtration is widely used in our society. Furnace filters remove dust from the air; swimming-pool filters remove large pieces of floating debris and small particles like sand and dust; the oil filter in a car removes the carbon and metal shavings produced by the engine; a gas filter removes rust from the tank and dirt from the gasoline pump; surgical masks filter bacteria in the air, as well as dust and other airborne pollutants; and charcoal filters are used in kitchen fans to reduce grease, odours, and smoke.
b) Distillation is used to produce distilled water for drinking and for use in irons and humidifiers. Fractional distillation is used to separate crude oil into such components as gasoline, diesel oil, heating oil, and lubricants.
c) Sedimentation and floc formation are used in sewage-treatment plants, water-purification plants, and septic tanks.

4. Societal Implications

a) The separation from air and water of the unwanted impurities generated by our industrial society helps protect our health and well-being.
b) Cigarette filters are intended to protect the health of the smoker, but they do not remove the gases that are produced when the cigarette is smoked.
c) New technology is used to recover valuable resources (e.g., aluminum from cans, zinc by separation processes from industrial waste).

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, including the separation of substances in a mixture;
b) records of experiments and science notes;
c) oral or written communication with other students and the teacher.

6. Safety Considerations

a) Mixtures that are poisonous, flammable, or corrosive should be handled with care. Students should keep liquids and solids away from their mouths and wash their hands after handling chemicals.
b) Adequate ventilation should be provided when alcohol is used. Open flames should be kept away from alcohol.
c) When a distillation is performed, the mixture should be heated gently.
d) Any distillate produced should not be tasted.

7. Possible Extensions

Some students might:

a) investigate the technique of chromatography to separate the substances in black ink and other liquids that are suspected of being mixtures;
b) hold a debate on a resolution such as "Our drinking water is safe" or "The pollution of our beaches is preventable";
c) investigate the use of a centrifuge to separate the components of a mixture.

8. Some Teaching Suggestions

a) The importance of "pure" substances in our daily lives and the limitations of current separation technology to separate out all contaminants should be stressed.
b) Students should use their prior knowledge concerning the states of matter to deduce the effectiveness of filters in dealing with gases in cigarettes.
c) The fact that the size of the particles determines the effectiveness of filtration should be stressed in activity 2b.
d) The water cycle in nature should be discussed and compared to the process of distillation in the laboratory. Students should have an opportunity to examine a Liebig condenser.
e) Each pair of students should distil only one of the mixtures in activity 2c. Students using other mixtures should share their results with the whole class.
f) Fractional distillation can be introduced as a simple extension of distillation. The practical value of fractional distillation can be illustrated by reference to its application in the petroleum industry.
g) If the equipment is available, the effect of a centrifuge on sedimentation can be demonstrated.
h) Field trips could be taken to water-purification plants, sewage-treatment plants, or oil refineries to observe separation techniques.

Optional Unit 3

Simple Machines

Time: 14 hours

Machines are used to transfer energy from one point to another. They are sometimes used to multiply force, sometimes to multiply speed, and always to gain some kind of advantage. All aspects of society make use of machines to accomplish daily tasks. This unit will introduce students to the laws of physics that govern the operation of a variety of machines. *Note*: The term *mechanical advantage* is to be interpreted for purposes of this unit as meaning the *actual* mechanical advantage based on the ratio of the load and effort forces. In some instances the *ideal* mechanical advantage is specified; it is based purely on the geometry of the machine.

This unit may be divided into topics such as the following:

- Simple machines
- Complex machines

1. Objectives

Attitudes. Students will be encouraged to develop:

a) curiosity about how simple machines have been used since early civilizations to make work easier (3a);
b) an interest in complex machines that are composed of different kinds of simple machines (2e, 3a, 8a).

Skills. Students will have the opportunity to develop skill in:

a) following simple procedures for assembling equipment and organizing data from written instructions (2a-2d);
b) taking accurate measurements and recording them in tables (2a-2d);
c) measuring the mechanical advantage of a simple machine (2b-2d);
d) applying the law of the lever to a simple lever (2a);
e) using a spring scale to measure force in SI units (2a-2d);
f) inferring how the length and height of an inclined plane affect the mechanical advantage (2b).

Knowledge. Students will be expected to:

a) state the main functions of simple machines;
b) list the six common simple machines and recognize that they can be grouped into two classes or families (i.e., the lever family and the inclined-plane family);
c) give a practical example of where and how each type of machine might be used (3a, 8a, 8d);
d) label the parts of a simple lever (2a);
e) identify the three classes of levers and give practical examples of each type;
f) define and calculate the mechanical advantage of simple machines and discuss the effect of friction on mechanical advantage (2b-2d, 8b, 8c);
g) state the law of the lever (2a);
h) realize that it is easier to lift an object up an inclined plane than straight up in a vertical direction (2b, 2c);
i) recognize that complex machines are combinations of simple machines (8a, 8d);
j) identify various types of simple machines in common devices.

2. Student Activities

Students are to:

*a) set up a simple lever and measure the force required to balance various loads that are placed at different distances from the fulcrum; tabulate the effort force, the load force, and the corresponding distances of the load and effort from the fulcrum; and verify the law of the lever in each case (6, 8b);
*b) set up an inclined plane; determine the mechanical advantage for at least two different angles of the inclined plane; tabulate the results; and try to predict what difference a longer ramp would make in raising an object through the same height (5b, 5c, 8b);
c) set up an inclined plane at a certain angle, determine the mechanical advantage for two different cases where the force of friction acting on the object differs, and then compare the results (5b, 5c, 8b, 8e);
d) determine the mechanical advantage for one of the following cases: (i) a single fixed pulley and then the combination of a single fixed pulley and a single movable pulley, (ii) a two

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* See the subsection entitled "Student Activities" on page 6.

double-pulley hoist (a simple block and tackle), or (iii) a wheel and axle; and then vary the load, tabulate the results, and find an average value (5b, 5c, 6b, 8b, 8f);

e) examine a number of items (e.g., hatchet, chisel, ladder, car jack, meat grinder, pencil sharpener, differential pulley, bicycle) and try to identify the simple machines in each (8a, 8d).

3. Applications

a) Simple machines are found in an enormous number of devices (e.g., woodworking tools, surgical instruments, construction machinery, wood and metal fasteners, kitchen utensils, farm implements). The automobile and tool-and-die industries also make extensive use of simple machines.

b) The study of levers has increased our knowledge of how the skeletal system functions in the human body. This knowledge has been used in the design of artificial limbs and of the robot arms that are being used in industry and in outer space.

4. Societal Implications

a) Machines form the foundation of our industrial society. Their use has increased our productivity and improved our standard of living.

b) Although machines offer great advantages, their indiscriminate use can waste energy and can lead to a deterioration in the health of individuals who use them instead of using their own bodies (e.g., taking the car instead of walking).

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, including their assembly and use of simple machines;

b) records of experiments, including measurements;

c) simple calculations to determine the mechanical advantage of simple machines.

6. Safety Considerations

a) When using a simple machine, students should be careful not to exceed its working capacity.

b) Precaution should be taken in case a heavy mass is accidentally dropped.

7. Possible Extensions

Some students might:

a) investigate the law of the lever using all three classes of levers;

b) determine both the actual mechanical advantage and the ideal mechanical advantage of a simple machine (e.g., an inclined plane or a pulley) and then calculate its efficiency;

c) measure the mechanical advantage of a bicycle in several different gears and compare the effect of applying the force at various pedal positions;

d) examine a belt or gear system and discuss how these devices are used in cars and bicycles to change speed and force;

e) examine how the ideal mechanical advantage is related to the number of ropes supporting the load in an arrangement of pulleys.

8. Some Teaching Suggestions

a) Students can give examples of machines that they have used and can explain how the machines operate (e.g., a vise, a winch, a block and tackle, a car jack, a door handle, a hand-operated meat grinder). Actual devices should be brought into the class if possible.

b) Mathematical problems should not be overemphasized in this unit.

c) It should be pointed out that the effects of friction are not necessarily disadvantageous. For example, the force of friction prevents screws from coming loose and the rope on a pulley from slipping out of the operator's hands.

d) A teacher from the technical area or a worker from industry can be invited to demonstrate and discuss how simple machines are used in the workplace and in vehicles.

e) In activity 2c, students can measure the force required to pull a cart up the inclined plane and then repeat the activity with the cart overturned to illustrate the effect of friction on the applied force.

f) In activity 2d, it should be emphasized that pulleys are machines that can change the direction of the applied force.

g) The concept of torque or moment of force and the two types, clockwise and counterclockwise, can be introduced in some classes. Torques or moments can be mentioned in reference to the lever and the wheel and axle.

Optional Unit 4

Locally Designed Unit

Time: 14 hours

This unit is to be designed at the local level as desired. It can be used to introduce a new area or topic of science not described in this guideline or to incorporate additional objectives that will expand a part or parts of the course already covered. Examples of new areas or topics that might be considered include the following:

- Agriculture
- Astronomy
- Careers in science
- Continuity
- Forestry
- Fungi and simple plants
- Machines
- Mechanics
- Separation of substances
- Vibrations and waves

This unit may provide an excellent opportunity for students to engage in independent study on a topic in science that is of particular interest and that is approved, monitored, and evaluated by the teacher. Students may work individually or in small groups. Care should be taken not to allow the work to overlap with subject matter in other science courses that students are likely to take. The unit could be started after students have had some experiences in the laboratory and are well aware of accident prevention. If a series of short topics is considered, the topics may be fitted into the course schedule from time to time throughout the semester or year.

It is expected that the local design of this unit will incorporate components similar to those adopted in the core units, namely, objectives, student activities, applications, and societal implications. A description of the unit is to be included with the school's course outline and kept on file so that it is available to interested students and parents.

Science, Grade 10, General Level
(SNC2G)

Core Units

Community Ecology
The Functioning Animal
Environmental Chemistry
Magnetism and Electricity
The Wise Use of Resources

(80 hours)

Optional Units

Astronomy
Minerals and Mining
Continuity
Metals
Terrestrial and Aquatic Ecosystems
Locally Designed Unit

(30 hours)

Core Unit 1

Community Ecology

Time: 16 hours

All living organisms are part of an ecosystem. Environmental problems result when the balance within the system is upset. In this unit students will learn to recognize ecosystems and their components, the relationships among the parts of an ecosystem, and the adaptations that organisms undergo in order to survive in their ecosystems.

This unit may be divided into topics such as the following:

- Ecosystems and their components
- The role of organisms in an ecosystem
- Food webs
- Populations
- Human influence on ecosystems

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a respect for the balance that exists in a natural community (8a);
b) a commitment to conserve our natural resources (3b, 4a, 4b);
c) a spirit of co-operation with other members of their team during group activities (5c).

Skills. Students will have the opportunity to develop skill in:

a) making a model of an ecosystem (2a);
b) setting up an ecosystem such as a terrarium or an aquarium (2a);
c) using accepted field methods to gather data for analysis (2a, 2b);
d) drawing food webs from provided data or field observations and showing the direction of flow of energy in the food web (2b, 8d);
e) estimating populations in an ecosystem from field work or from data provided (2b);
f) recording physical (abiotic) data about a given ecosystem (2a, 2b);
g) identifying (when feasible) living organisms in given areas (2a, 2b);
h) reporting their field observations orally or in writing (2a, 2b);
i) predicting effects that will occur in ecosystems if any of the components are changed (8e);
j) analysing an ecosystem to discover the nature of the organisms present, the niches they occupy, and the relative abundance of the organisms (2b);
k) graphing population data (2b).

Knowledge. Students will be expected to:

a) explain the parallels between a model of an ecosystem and a real ecosystem (2a, 8c);
b) name the characteristics of the abiotic environment in which selected organisms live (2a);
c) define or give examples of the following: ecosystem, habitat, niche, food chain, food web, community, population, biotic component, abiotic component;
d) define or give examples of the following: producer, consumer, decomposer, herbivore, carnivore, omnivore, predator, prey;
e) explain why biologists take random samples to estimate populations in an ecosystem (2a);
f) list the factors that place limits on populations;
g) describe one or two nearby ecosystems;
h) state the effects on a given ecosystem of adding or removing one or more organisms or abiotic factors;
i) explain how people can affect the environment by their behaviour.

2. Student Activities

Students are to:

*a) either (i) create a model of a particular ecosystem that will include identifiable living and non-living components and then, using the components of the model, create an ecosystem in an aquarium or terrarium *or* (ii) select a defined area for field study (e.g., a park, field, forest, woodlot, marsh, pond, beach) and, using accepted sampling techniques such as quadrat sampling or line-transects, establish the type of organisms that form the community of the area (5a, 5b, 8a, 8c);

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* See the subsection entitled "Student Activities" on page 6.

*b) analyse collected data to estimate the population of the component species of a community, graphically illustrate the results, and speculate from the data on food chains or webs existing in the studied area (5b);
c) write a co-operatively planned essay, using supplementary resources, on a local, provincial, federal, or international ecological issue (8b).

3. Applications

a) Natural disasters such as forest fires and volcanic eruptions change the balance in an ecosystem and make it possible for new species to become established.
b) A knowledge of ecology has led to restrictions on the importing of foreign species of plants and animals and to regulations for the discharge of industrial wastes into the environment.

4. Societal Implications

a) Human activities have a profound effect on ecosystems, for example, by destroying the habitat of specific species while improving that of others (e.g., drainage of marshes for urban development).
b) Disagreement or lack of information about the size of populations and the relationships among different species in an ecosystem can lead to controversy. The seal hunt in Newfoundland and the shooting of wolves in British Columbia are two examples.
c) The long-term effect on ecosystems of the use of chemicals in new pesticides and herbicides is not yet fully known.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory or field work, such as the random selection of a study site and the subsequent collection and identification of specimens;
b) analysis of data, graphs, and reports;
c) co-operation and oral or written communication with the teacher and other students.

6. Safety Considerations

a) Unknown plants should not be tasted or eaten.
b) Field-studies sites should be examined for any poisonous plants.
c) Student allergies to plants should be reported to the teacher.
d) Students should wash their hands after handling soil or plants.

7. Possible Extensions

Some students might:

a) investigate the role of cycles of matter in an ecosystem;
b) investigate populations and communities in a particular biome;
c) investigate the concept of adaptation by looking at examples of camouflage, mimicry, and special structural or behavioural features of organisms.

8. Some Teaching Suggestions

a) If at all possible, field work should form the focus for the whole unit. Teachers can organize an extended field trip or they can, if necessary, use the schoolyard or a local park.
b) The use of films, filmstrips, games, and newspaper clippings and other representative information from the news media would enhance the content of this unit.
c) A model for an ecosystem can be introduced by having students imagine the needs of an organism such as a grasshopper or a mouse in an empty, sealed container. The substances and conditions that the organism needs to survive over a long period can be identified and then added to the model.
d) Students can discuss the flow of material and energy in their own day's activities. The Grade 9 core unit 5, "Green Plants", could provide some background for this activity.
e) Ecosystem games, available as board games or on computers, could be used as incentives to help students improve their problem-solving skills.
f) The individual's responsibility to protect the environment should be emphasized throughout the unit.

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* See the subsection entitled "Student Activities" on page 6.

Core Unit 2

The Functioning Animal

Time: 16 hours

Animals are consumers that must have an external source of energy or food. Each animal has specialized systems that it uses to acquire and process this food. In this unit students will investigate the respiratory and digestive systems of several organisms, including the human organism. The laboratory activities are the focus and starting point for these investigations. Some aspects of this unit may be part of the health program in the school. Co-operative planning should take place so that the science and health programs complement each other and any overlap is treated from their different perspectives.

This unit may be divided into topics such as the following:

- Oxygen and food: necessities of life
- Gas exchange
- The respiratory system
- The circulatory system
- The digestive system
- Removing the wastes of respiration

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the complexity of the human body (8a, 8b);
b) a willingness to consider the effect on their bodies when making decisions about eating and the use of alcohol, tobacco, or other drugs (2e, 3b, 3c, 4a);
c) a respect for the importance of diet and exercise in maintaining (or attaining) a healthy body (2e, 3c, 3d, 4a);
d) a critical approach to examining food labels as a source of information about nutrients (3a).

Skills. Students will have the opportunity to develop skill in:

a) performing an experiment to measure the vital capacity of their lungs (2a);
b) performing a test for the presence of carbon dioxide and water in exhaled air (2b);
c) dissecting a preserved specimen such as an earthworm, an insect, or a vertebrate to observe the systems being studied (2c);
d) labelling a diagram or diagrams of the major organs of digestion, circulation, respiration, and excretion of the animal dissected (2d, 5b, 8d);
e) tracing the path of food through the digestive tube of the dissected organism (2c);
f) labelling diagrams of the human respiratory and digestive systems;
g) doing an experiment to demonstrate the function of enzymes in digestion (2d).

Knowledge. Students will be expected to:

a) recall that the cell is the basic unit of structure, through which chemical energy is released in different forms;
b) differentiate between the gases contained in inhaled and exhaled air (2b);
c) describe the functions of the following: diaphragm, muscles of the rib cage, nasal passages, cilia, mucus, pharynx, trachea, epiglottis, bronchi, bronchioles, alveoli;
d) explain how the circulatory system transports gases and nutrients;
e) trace a drop of blood through the human heart from the vena cava to the aorta;
f) compare the adaptations to their environments of the respiratory systems of organisms such as earthworms, frogs, and humans (8d);
g) describe how the respiratory system is affected by two or more of the following respiratory ailments: colds, influenza, bronchitis, whooping cough, asthma, laryngitis, pneumonia, tuberculosis, pleurisy, emphysema, cancer;
h) list at least three ways in which smoking harms the respiratory system (8b);
i) explain why digestion is necessary;
j) describe the function of the following organs in digestion: mouth, salivary glands, esophagus, stomach, small intestine, large intestine, liver, gall bladder, pancreas (2d);
k) describe how the digestive system is affected by two or more of the following digestive ailments: heartburn, ulcers, gallstones, cirrhosis, jaundice, hepatitis, diabetes, appendicitis, diarrhoea, constipation;
l) describe some adaptations to their environments of the digestive systems of organisms such as earthworms, frogs, and humans;
m) describe the role of the lung, skin, and kidney in the removal of the wastes produced by respiration.

2. Student Activities

Students are to:

*a) investigate the relationship between the vital capacities of students' lungs and such factors as sex, mass, and the effect of exercise;
*b) test for the presence of carbon dioxide and water in the gases they exhale (8c);
*c) dissect an organism that will illustrate the major organs of digestion, circulation, respiration, and excretion (5b, 6c-6e, 8d, 8g);
*d) experimentally show that enzymes are responsible for digesting starch, for example; this process converts the large molecules of starch into smaller molecules of sugar (5a, 8e);
e) draw up a list of substances and habits in their lives that benefit or harm their digestive and respiratory systems (8f).

3. Applications

a) Food labels are an important source of information about the ingredients and nutrients contained in foods.
b) A knowledge of how the respiratory system functions may encourage students to refrain from smoking or to protect themselves from harmful gases.
c) A knowledge of nutrition and the digestive system may encourage students to choose a balanced diet.
d) The heart is a muscle that will perform more efficiently when regularly exercised.

4. Societal Implications

a) By selecting a lifestyle that includes diet consciousness (in terms of both quantity and quality of food), regular exercise, and the avoidance of tobacco, alcohol, and non-prescription drugs, individuals will increase their chances of experiencing generally good health.
b) The long-term effect of some food additives and airborne pollutants on human health is not fully known.
c) Substances such as pesticides and hormones are used to improve crop and herd yields.
d) The specimens used in dissections are often collected from their natural habitat. There is a responsibility to see that this practice is minimized and does not threaten natural populations.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, such as a demonstration of the effect of enzymes on starch;
b) identification of structures in a dissected organism;
c) reports, drawings, and notes.

6. Safety Considerations

a) Preserved specimens should be rinsed before being handled.
b) Students should wash their hands after handling chemicals and preserved specimens.
c) Dissecting tools such as forceps, T-pins, probes, and scissors should be used correctly. Scalpels should be used only if absolutely necessary and then with direct supervision.
d) Biuret reagent contains sodium hydroxide and should not be allowed to touch the skin.
e) Appropriate eye protection should be worn during a dissection.

7. Possible Extensions

Some students might:

a) measure the lung capacity of a large sample of students to test some hypotheses as to why there are individual differences in a population;
b) discuss, demonstrate, or experiment with the effects of particle size on the rate of digestion;
c) write a short speech (or letter) or design a poster to discourage students from smoking.

8. Some Teaching Suggestions

a) Students' interest in the respiratory and digestive systems could be aroused by asking them to name diseases and disorders of those systems.
b) The normal functioning of the organ or system should be described before the state and functioning of a diseased organ or system are discussed.

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* See the subsection entitled "Student Activities" on page 6.

c) For activity 2b, a student should breathe in and out of a small plastic bag containing a few drops of bromthymol blue or limewater. Students should apply their knowledge of cellular respiration and of the carbon dioxide test to predict the result.
d) While students are dissecting, questions should be asked to draw their attention to the functions of the parts of, special adaptations of, and similarities and differences among organisms. Certificates of accomplishment could be given for the various stages of the dissection. Students should also be urged to respect life and to use dissection only when necessary.
e) In activity 2d on enzyme action, the need for a control should be stressed and the differences between observing and inferring should be emphasized.
f) Students should work in groups for activity 2e. Points could be assigned to the various factors, and students could assess their own living habits. Such an assessment should be based on self-evaluation and should not lead to personal embarrassment.
g) To illustrate the system being studied, organs could be brought in from a butcher's shop (e.g., swine lungs, beef heart, kidney, tripe).

Core Unit 3

Environmental Chemistry

Time: 16 hours

Since the Second World War thousands of new chemicals have been manufactured for a variety of industrial, agricultural, and medical purposes. Many of these are eventually released into the environment. The long-term environmental effect of such chemicals is unknown. An understanding of some aspects of environmental chemistry will provide students with a background to help them make decisions about using chemicals themselves and also to look critically at the use of chemicals in industry.

This unit may be divided into topics such as the following:

- Acids and bases
- Air pollution
- Water pollution
- Controlling pollution

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an awareness that technology can both lead to and solve environmental problems (3a, 3b, 4a);
b) an interest in the economic benefits of, and the ecological problems caused by, industrial or agricultural processes (4a-4c);
c) a commitment to maintain a clean environment (3b, 4a).

Skills. Students have the opportunity to develop skill in:

a) testing substances to determine whether they are acids or bases (2a);
b) applying the test for acids and bases to some everyday substances, such as vinegar, lye, household ammonia, oven cleaner, and furniture polish (2a);

c) observing through simulations the effects of chemicals on their environment (2b, 2c, 2f);
d) doing water analyses (2d, 2e);
e) handling chemicals in water-testing kits (2d, 2e);
f) recording the findings of water analyses (2d, 2e).

Knowledge. Students will be expected to:

a) explain, by means of operational definitions only, the difference between an acid and a base (2a);
b) give examples of pollutants, their sources, their possible effect on living organisms, and possible ways of controlling them (5c);
c) discuss thermal pollution in relation to the concentration of dissolved oxygen needed for aquatic life (2d);
d) describe the effects of acids and bases on litmus, bromthymol blue, and phenolphthalein (2a);
e) describe the effect of acid rain on leaching in soils (2c, 8c);
f) describe the different effects of acid rain on lakes with hard and soft water (2f, 8c);
g) explain how atmospheric conditions can hasten or retard the spread of airborne pollutants.

2. Student Activities

Students are to:

*a) test the effect of an aqueous solution of sulphurous acid on phenolphthalein, litmus, and bromthymol blue and then perform acid and base tests on various household chemicals (6b, 6c);
b) produce sulphur dioxide by burning sulphur in a gas-collecting bottle containing a small amount of water and test the resulting solution with an acid-base indicator (6a, 6c);
c) test soil quality (nitrogen, phosphorus, and potassium levels) before and after the run-off of sulphurous acid (6b, 6c, 8a);
d) test water to show the concentration of dissolved oxygen (6b, 8a);
*e) compare the water quality of tap water and a nearby stream, lake, or river by testing for some of the following: pH, hardness, alkalinity, turbidity, colour (6b, 8a, 8e);
*f) through experimental simulations, show the comparative effect of acid rain on the pH of soft and hard water (6b, 6c, 8c).

3. Applications

a) The testing of water in wells and in water-treatment plants helps to maintain an acceptable water quality.
b) The monitoring of air pollution warns people of potential health hazards, especially in heavily industrialized areas.

4. Societal Implications

a) The increased knowledge of environmental pollutants may result in an increased awareness of our obligation to limit the overuse of various substances, such as fertilizers, herbicides, pesticides, and leaded gasoline.
b) Because air and water pollution crosses borders, good international relations (e.g., between Canada and the United States and between Britain and Europe) must be established so that mutual problems can be solved.
c) Public cognizance of environmental pollution could bring controls that would safeguard the environment; however, serious restrictions could be imposed on industries that provide jobs for many people.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work, such as the testing for acids and bases;
b) science notes and records of experiments;
c) lists of pollutants, their sources, their effects on living organisms, and ways of controlling them.

6. Safety Considerations

a) The production of sulphur dioxide should be done in a well-ventilated area. This experiment, activity 2b, should be demonstrated if adequate ventilation cannot be provided for a class experiment.
b) Students should wash their hands after handling chemicals, soil, and untreated water.
c) Students should be warned that acids or bases should not touch their skin or clothes.

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* See the subsection entitled "Student Activities" on page 6.

7. Possible Extensions

Some students might:

a) visit a sewage-treatment plant and write a report on its operation;
b) obtain information from the Ministry of the Environment (Water Resources Branch) on the variation of the concentration of dissolved oxygen throughout the year in a nearby stream or lake and use these data to investigate the effect of temperature on the concentration of dissolved oxygen;
c) investigate techniques used by local farmers and industries to prevent or counteract pollution;
d) use a water-testing kit to detect various heavy metals (e.g., mercury, lead, zinc, silver, nickel) in the water of a nearby stream, river, or lake.

8. Some Teaching Suggestions

a) A variety of water and soil-testing kits can be obtained from commercial suppliers.
b) Students can keep a scrapbook on environmental issues that apply to the local area.
c) Current information about acid rain and other pollutants can be collected from newspapers and magazines and then discussed in class.
d) Guest speakers can be invited to talk about a local environmental problem or decision.
e) Students can do a project on environmental pollution and present their findings to the class. For example, rivers and lakes must now be protected against noxious effluents and airborne pollutants; tap water must be transported and treated; and there is a price to be paid for water purification. Students can find information on such issues and express their own reactions.

Core Unit 4

Magnetism and Electricity

Time: 16 hours

Electricity and electric machinery and appliances are so much a part of our lives today that most people cannot imagine life without them. This unit will introduce students to the electric effects of static charges, the sources of the electricity they use every day, simple circuits, and the safe use of household electric appliances.

This unit may be divided into topics such as the following:

- Static electricity
- Current electricity
- Applications and uses of electricity
- Magnetism and electromagnetism
- The generation of electricity

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an interest in the ways in which electricity is generated (3a, 3b);
b) an awareness of the need to use electricity safely (6c-6e, 8a);
c) a concern for the conservation and wise use of electricity (4a, 4b).

Skills. Students will have the opportunity to develop skill in:

a) tabulating information from experiments with static electricity and chemical batteries (2a, 2b);
b) making chemical batteries from different materials (2b);
c) measuring currents and voltages (2b, 2e, 2h);
d) connecting a simple series and a simple parallel circuit (2f);
e) interpreting and using the information found on the plates of electrical appliances (2j).

Knowledge. Students will be expected to:

a) state the effects of charged objects on each other and on other neutral objects (2a, 8b);
b) explain how to make a chemical battery (2b);
c) describe the effect of magnets on various materials (2c-2e, 8c);
d) describe the magnetic effects produced by passing an electric current through a conductor (2g, 2h, 8e);
e) explain how to produce an electric current using a conductor and a magnet (2i, 8e);
f) explain how to test a circuit for an electrical current and voltage (2f, 8d);
g) compare a series circuit with a parallel circuit (2f, 8d);
h) distinguish between a motor and a generator (2h, 2i, 8e);
i) describe how a circuit becomes overloaded (2j, 8f);
j) list and briefly explain the various sources of energy for producing electricity.

2. Student Activities

Students are to:

*a) create static electrical charges on a number of objects, such as pith balls, metal leaf electroscopes, ebonite rods, and glass rods; attempt to discharge the electricity to the ground using a variety of conductors and insulators; and investigate the effects of charged objects on each other and on neutral materials, such as small pieces of paper, chalk dust, or smoke (8b);
*b) make a number of chemical batteries, using a variety of liquids and metals, and measure the voltage of each battery with a voltmeter (6a, 6c, 8a);
c) observe the effect of a bar magnet on iron filings through several different materials (e.g., waxed paper, glass, sheets of metal, wire gauze);
d) make a magnet by half-filling a test tube with iron filings and stroking the test tube in one direction with the north pole of a bar magnet; test the polarity with a compass; and test the polarity again after shaking the test tube;
e) observe the effect of magnets on blank tape cassettes, recorded tapes, and the speakers of radios that are being played (6b, 6d. 8c);
*f) connect several light bulbs in series and in parallel to a low-voltage D.C. power source; compare the voltages and currents in these circuits; and unscrew one bulb in each circuit and observe what happens (5a, 6c, 6d, 8d);
g) use a heavy-gauge insulated copper wire, a compass, and a D.C. power source to observe the magnetic effects of a current-carrying conductor; repeat using a helix; and construct a simple electromagnet (6d, 8e);
h) observe the motion produced when an electric current is passed through a conductor that is suspended between the poles of a horseshoe magnet (6d, 8e);
i) use a single wire connected to a sensitive galvanometer to observe the current produced when the wire is moved rapidly through a strong magnetic field. They then repeat the activity by moving a coil through the magnetic field (8e);
*j) record and tabulate the information found on the electrical plates of several electrical appliances in the home and school and determine which appliances can be used together without overloading a household circuit (8f).

3. Applications

a) Batteries as a source of energy have many applications (e.g., in automobiles, light sources, toys, calculators, portable radios, smoke detectors, watches).
b) The interrelationship between electricity and magnetism is utilized in devices such as motors, generators, electromagnets, loudspeakers, and transformers.
c) One method of removing pollutants from smoke uses electrostatic precipitators to attract the particles of the pollutants. Thus, air purifiers create an electrical charge that attracts the particles of smoke and dust in the air.

4. Societal Implications

a) The most common methods of generating electricity all have an impact on the environment: hydro-electric power often requires the building of dams; when fossil fuels are burned, air and water are usually polluted; nuclear generation produces radioactive waste.
b) The use of electricity has transformed every aspect of life in the home, on the farm, and in the workplace.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work (e.g., wiring a simple circuit);
b) science notes and records of experiments.

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* See the subsection entitled "Student Activities" on page 6.

6. Safety Considerations

a) Students should be warned that some of the chemicals being used may be corrosive to skin and clothes. Protective eyewear should be worn when appropriate.
b) When demonstrating the effect of a magnet on a radio speaker or cassette, students should be careful not to cause an accidental grounding by touching the magnet to a live wire. A small, battery-powered radio should be used rather than one that is plugged into a house socket.
c) Students should be informed that the range selected on an electric meter must be suitable for the circuit being tested.
d) Laboratory experiments should not involve 110 V (alternating current). Low-voltage power sources should be used.
e) Students should be warned not to touch conductors that carry large currents, since they could be extremely hot.

7. Possible Extensions

Some students might:

a) investigate the way in which static electricity makes some clothes cling and how antistatic materials and devices work on records and in clothes dryers;
b) build a model of a household circuit (e.g., a grounded light socket controlled by a switch or a three-prong duplex receptacle);
c) construct a simple D.C. motor and explain its operation;
d) examine the structure of commercial plugs, sockets, circuit breakers, fuses, and connectors and explain or demonstrate their use by building simple circuits.

8. Some Teaching Suggestions

a) The safety precautions to be taken in working with electricity should be stressed at all times. Students should understand the principles on which the precautions are based.
b) Students should learn that electricity flows through conductors and not through insulators and that ground wires remove unwanted static charges. Computer shielding and grounding can also be discussed. Students should verify the basic law of electrostatic attraction and repulsion.
c) The discussion of the effect of magnets on tapes should include the care of tapes.
d) When teaching parallel circuits, teachers should emphasize that the parallel connection of loads is the standard method used in homes. The importance of complete and short circuits could be demonstrated, and the purpose of ground wires discussed.
e) If students do not do activities 2g-2i, then the various electromagnetic effects could be demonstrated. A D.C. power supply capable of delivering a large current can be used. A knowledge of hand rules is not required until Senior physics courses are taken.
f) An examination of the power or current rating shown on the plates of various appliances should help students to understand how to prevent overloading circuits at home. The formula *power (watts)* = *voltage (volts)* × *current (amperes)* could be used to calculate the current used by a particular appliance. These calculations should not be overemphasized.

Core Unit 5

The Wise Use of Resources

Time: 16 hours

Humans are using up the earth's natural resources at an alarming rate. If this continues, some of the earth's resources will be in very short supply. This unit will deal with the depletion of non-renewable resources and the creation of unwanted by-products. It will also introduce the idea of a conserver society and help students to analyse society's and their own use of energy and natural resources.

This unit may be divided into topics such as the following:

- Energy: types, sources, and measurement
- Energy systems
- Industrial processes and energy consumption
- Conserving energy and resources

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation for the part played by energy and natural resources in our high standard of living (4a);
b) a willingness to base their own use of energy and natural resources on the principles of a conserver society (2b, 3b).

Skills. Students will have the opportunity to develop skill in:

a) analysing the kinds of energy transformations that take place in some familiar situations such as in making toast, using an electric lawn mower, and setting off a burglar alarm (2a);
b) making intelligent and logical decisions about their own use of energy and resources (2b);
c) using tables and graphs to record and display facts pertaining to energy consumption (2b, 2c);
d) controlling variables (2c);
e) developing a report on reducing energy consumption (2g).

Knowledge. Students will be expected to:

a) give an operational definition of *energy*;
b) give an operational definition of *an energy system* (2a);
c) analyse a simple energy system by comparing the energy that is put into it, the intended output of energy, and the energy that is wasted (2a);
d) distinguish between renewable and non-renewable sources of energy and give examples of each;
e) explain the concept of a conserver society;
f) describe how energy consumption is measured in their homes and vehicles (2b, 8a);
g) describe ten ways to reduce the consumption of energy and resources (2b, 5d, 8d);
h) describe the outcome of an exponential growth of consumption in a closed system;
i) list the main sources of the energy used in Ontario today;
j) describe the sequence of events, the use of energy, the waste products, and the employment opportunities for at least one example of the conversion of a non-renewable resource into a manufactured product.

2. Student Activities

Students are to:

*a) examine several "systems" that have been set up in the laboratory (e.g., battery and motor, solar cell, flashlight, radiometer) and describe the energy transformations that occur (5c, 6a);
b) record data and show related calculations of their own use of energy (including oil, gas, and electricity) and of personal appliances for a given time period; this should be done by referring to meters, data tables, and power-rating plates on appliances (5a, 8a);
c) compare the flow of heat through different insulated materials and, in their investigation, control variables, state hypotheses, and record findings (8b);
d) using a "recipe" and available raw materials, manufacture one or two substances (e.g., nylon, glass, paper, dyes, glue, cosmetics, acetylsalicylic acid or ASA, soap, rubber, metal, ice cream) and report on the energy and raw materials used, the new substances obtained, and the waste products for each process (6, 8c);
e) recycle paper from old newsprint (6c);

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* See the subsection entitled "Student Activities" on page 6.

f) investigate the operation of a simple solar collector, compare the energy absorbed by a shiny and a dark surface, and study the effect of varying the angle of the incident radiation;

*g) do a library search on an energy-related topic of interest, such as tracing one major energy resource (e.g., oil, natural gas, coal, nuclear fission, solar power, water power) from its source to the consumer or comparing the processes of recycling aluminum and glass bottles (8d).

3. Applications

a) Manufacturers continually try to reduce the amount of energy wasted in the manufacturing process.

b) Many individuals participate in recycling programs to help conserve natural resources.

4. Societal Implications

a) The availability of inexpensive electricity and petroleum products has greatly improved our standard of living. However, consumers have tended to be wasteful.

b) The disposal of domestic garbage is becoming more difficult and controversial as landfill sites are used up. Recycling processes are being encouraged to cut down the amount of waste.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) records of their own use of energy or that of their families during a given period;

b) laboratory work (e.g., the manufacture of a substance from raw materials);

c) analysis of energy transformations in common events;

d) arguments (presented orally, in writing, or in graphic form) for reducing our consumption of natural energy resources.

6. Safety Considerations

a) Appropriate precautions should be taken in using open flames and electrical devices.

b) Students should be informed of the appropriate precautions to take when manufacturing a given substance.

c) Students should wear appropriate protective eyewear when heating or mixing chemicals.

7. Possible Extensions

Some students might:

a) compare several consumer products in terms of the following: the energy and resources used in their manufacture, the disposal of by-products, the energy required to use the product, and the social benefits of the items;

b) using existing information, draw up a plan for minimizing the use of energy in a household and list the expectations in terms of feasibility and savings;

c) compare the R-values of common materials and apply this knowledge to a brief report on the insulation of buildings;

d) use data tables of known reserves and graphs of predicted consumption to predict future supplies of natural resources. This may be done as a computer simulation.

8. Some Teaching Suggestions

a) Early in the unit students should be given help in organizing the procedures and tables that they need in order to record their own or their family's consumption of energy.

b) Students can construct a model house out of cardboard boxes. The walls, floor, and ceiling can be insulated with a material such as polystyrene. A heated object such as a beaker of hot water can be placed inside the house, and the temperature measured over a period of time. This can be repeated with the heat source placed outside the house. Different insulating materials, such as vermiculite, air and glass, and mineral or cellulose fibres, can be used. If the various types of insulation are to be compared, the model house should be designed to accommodate equal thicknesses of insulation. The advantages and disadvantages of the various types of insulation can be discussed, and the importance of sealing drafts should be stressed.

c) If available, products manufactured by local industries can be used in activity 2d.

d) Class sets of booklets can sometimes be obtained from government agencies, conservation organizations, oil companies, mining companies, and local industries.

e) Guest speakers can be invited from the community to speak on industrial processes and the energy transformations involved.

f) The Ministry of Education publication *Energy in Society: A Resource Guide for Teachers* contains many suggestions that can be used to enhance this unit.

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* See the subsection entitled "Student Activities" on page 6.

Optional Unit 1

Astronomy

Time: 15 hours

Astronomy is the branch of science that deals with the universe beyond the earth's atmosphere. It has an appeal and is accessible to young and old alike, partly because it is exciting and therefore newsworthy and partly because the beauty of the sky can be appreciated by everyone. Astronomy provides an enjoyable leisure activity for thousands of Canadians and employment opportunities for others. This unit emphasizes two aspects of astronomy that are appropriate for students working at the general level in science: the observation of the sky and the understanding and appreciation of current developments in astronomy as reported in newspapers and other secondary sources. The emphasis is on astronomy as an enjoyable interest, observational activity, or leisure pursuit, rather than on astronomy as an academic discipline. Students will be encouraged to develop the skills of observing, recording, reading, writing, and speaking while dealing with the various aspects of this unit.

This unit may be divided into topics such as the following:

- Motions in the sky
- The solar system
- Beyond the solar system

Alternatively, topics such as the following may be chosen:

- Observing the sky by day and night
- Current knowledge and developments in astronomy

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the vastness and beauty of the universe and the variety of the objects in it (2a, 2b, 2f-2h);
b) an awareness that astronomy develops primarily through observation rather than through experimentation (2i);
c) an appreciation of the order in the universe and of the fact that our understanding of it has been gained through scientific investigation;
d) a realization that our understanding of the universe represents current knowledge and that some aspects of it may change as more knowledge accumulates (2i, 2j);
e) a curiosity about the universe and the objects in it (2i, 2j, 3c, 4e-4g);
f) an awareness of the role and the techniques of the various media in reporting scientific discoveries and developments (2i, 2j, 4b);
g) a more positive self-concept as a result of understanding the universe.

Skills. Students will have the opportunity to develop skill in:

a) setting up and keeping a journal of their astronomical observations, using appropriate methods of recording (2a-2c, 2e, 2f, 8b-8h);
b) using a simple sky chart to locate objects in the night sky (2f, 8b, 8d, 8g);
c) determining compass directions with the aid of the stars by night and the sun by day (2e);
d) illustrating and explaining the phases of the moon by means of a simple model (2c, 8f, 8h);
e) conducting simple experiments to study the appearance or properties of the sun (2h);
f) observing and interpreting photographs of astronomical objects (2d);
g) visualizing the arrangement and distance of objects in the universe (2g);
h) reading, interpreting, and evaluating newspaper or magazine articles dealing with current developments in astronomy (2i, 2j, 8k-8n);
i) preparing and presenting an oral or written report on a current development in astronomy (2j, 8j, 8k, 8m, 8n).

Knowledge. Students will be expected to:

a) explain the following terms and be able to recognize these objects (where applicable) in the night sky or in photographs: universe, galaxy, star, star cluster, constellation, nebula, planet, satellite (or moon), asteroid, comet, meteor, meteorite;
b) distinguish between the terms *rotation* and *revolution*;

c) describe the use and the importance of the telescope and other instruments as tools to gather and focus light and to record astronomical information;
d) describe the observable effects of the earth's eastward rotation on its axis, such as the changing length and direction of shadows during the day (2e);
e) demonstrate or describe how to determine compass directions with the aid of the stars by night and the sun by day (2e);
f) explain the phases of the moon in terms of the moon's reflection of sunlight and its revolution about the earth (2c);
g) identify and describe the principal features on the surface of the moon, such as mountains, maria, craters, and rays (2b, 2d);
h) name the planets of the solar system in order outwards from the sun and describe their revolution and the arrangement of their orbits in space (2g);
i) list the major or unique characteristics of the sun and each of the planets in the solar system (2d, 2h);
j) identify, through direct observation or by means of a simple sky chart, certain bright stars and easily recognized star patterns in the sky (2f);
k) state the approximate time required for light to travel to the earth from (i) the moon, (ii) the sun, (iii) the planets, (iv) the nearest stars, (v) the nearest galaxies, and (vi) the outer edge of the visible universe;
l) recognize that newspapers and other secondary sources may provide information about current developments in science (2i, 2j).

2. Student Activities

Students are to:

*a) keep, throughout this unit, a journal of their astronomical observations (5a, 8b-8h);
*b) observe (with the naked eye, a pair of binoculars, or a telescope) the major features on the surface of the moon and record or describe their observations (6b, 8h);
*c) observe the phases of the moon, record their observations, and use a simple model to describe and explain why the phases occur (6b, 8f, 8h);
d) describe, from observations of photographic prints or slides, the appearance of the moon and planets in the solar system;
e) determine compass directions with the aid of the stars by night and the sun by day (6a, 6b);
*f) with the aid of a simple sky chart, locate and observe some stars (e.g., Polaris, Sirius, Vega, Betelgeuse, Rigel, Deneb, Altair, Arcturus), some constellations (e.g., the Big Dipper, the Little Dipper, Cassiopeia, Orion, Pegasus, Leo), and any bright planets that are visible in the current night sky (5b, 6b, 8b, 8d, 8g);
g) construct a scale model of the solar system, using the same scale (if possible) for the sizes of the sun and planets and the distances between them (8i);
h) investigate the properties and appearance of the sun (a typical star) by doing experiments such as projecting an image of the sun onto a suitable surface (6a, 8h);
i) read a newspaper or magazine article dealing with a current discovery or development in astronomy and, as a class project, analyse the vocabulary used, the content, and the implications of the article (8k-8n);
*j) prepare, alone or in a group, an oral or written report on a current development in astronomy, using one or more newspaper or magazine articles augmented if possible by background material from the school library (5b, 8j, 8k, 8m, 8n).

3. Applications

a) The regular apparent motions of the sun, moon, and stars in the sky have been the basis for the measurement of time for centuries.
b) Objects in the sky have been and are used to determine directions and positions on the earth and are the basis for much navigation.
c) The desire to understand the universe has stimulated the development of instruments such as telescopes and vehicles such as spacecraft.
d) The sun is the primary source of energy for the earth.

4. Societal Implications

a) Astronomy provides an enjoyable leisure-time activity for thousands of Canadians. As well, many careers are related to astronomy and the exploration of outer space.
b) A scientifically literate society must be able to understand and interpret the information on current scientific developments that is provided by the media.
c) The study of astronomy has led to the development of the calendar and the dating of events in history.
d) The use of astronomical observations in the prediction of certain events (e.g., floods, seasons, eclipses) has influenced societies for centuries.
e) Astronomy provides information about the place of the earth in space and time and encourages speculation about its origin and future. It stimulates the imagination and contributes to a sense of shared exploration and intellectual excitement.
f) People living away from the lights of urban areas can experience the full beauty and wonder of the night sky (e.g., the aurora borealis).
g) An understanding of outer space complements a study of the earth's surface and atmosphere and provides a more complete view of the place of human beings in the universe.

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* See the subsection entitled "Student Activities" on page 6.

5. Evaluation of Student Achievement

At least 40 per cent of the term mark for this unit is to be based on students':

a) observations recorded in their journals;
b) identification of sky objects with the aid of a simple sky chart;
c) oral or written reports on a current development in astronomy.

6. Safety Considerations

a) Students should never look directly at the sun, especially when using binoculars or telescopes. They should be informed that the best way to view the sun with a pair of binoculars or a telescope is by projection.
b) Precautions should be observed if students are to observe the sky at night, either at home or at school. Such precautions include the following:

- Students should not have to travel or work alone in isolated areas.
- Students should beware of obstacles and other sources of danger when working in the dark.
- Teachers should ensure that extension cords that are used outdoors (e.g., for telescopes) are properly grounded.
- Parents and guardians of students should be informed of any assignments that students are required to do involving observation of the sky late at night.

7. Possible Extensions

Some students might:

a) visit a planetarium or observatory or attend a meeting of an astronomy club such as the Royal Astronomical Society of Canada;
b) invite an amateur astronomer to share his/her interest in astronomy with the class;
c) photograph the sky and some of the objects in it;
d) organize or take part in an evening "star night" at the school or in the community;
e) during the school year, observe and record the changes in time and position on the horizon of sunrise and sunset;
f) explain and demonstrate how latitude on the earth may be determined by sighting the altitude of the North Star;
g) investigate the development of the calendars used in the past and present by various groups (e.g., Chinese, Christian, Islamic, Jewish);
h) investigate the life and work of an astronomer, past or present;
i) read a science-fiction story and discuss the relationship between science and science fiction;
j) produce a class newspaper or magazine on astronomy;
k) prepare and present astronomy-related news items for the school public-address system;
l) produce astronomy-related exhibits for a school bulletin board or display case;
m) use star charts or a planisphere to become acquainted with the stars and constellations visible at various times of the year.

8. Some Teaching Suggestions

a) This unit highlights both some basic astronomical concepts that are not likely to change and current developments in the field. The latter are dealt with in activities 2i and 2j. These activities make it possible to capitalize on astronomical events such as eclipses, spacecraft missions, and new discoveries that may occur during the year.
b) Students should be encouraged to observe and record in their journals one astronomical object or event each week. Suggestions for these "objects of the week" may be found in astronomy columns in newspapers or other sources. The teacher can focus students' attention on each object by posing a question or two that can be answered by observation. In this way, students will become familiar with several objects in the sky in the course of a term or year. Similarly, in activity 2f, a few specific objects on the simple sky chart should be highlighted.
c) This unit highlights the observation of the sky but places less emphasis on independent, long-term observations than does the astronomy unit in the Grade 10 advanced-level science course. However, long-term observations *may* be possible, especially if teachers can plan the observing activities so that students can share observations made by different students at different times.
d) The emphasis in activity 2f is on the use of a simple sky chart. Although several stars and constellations are listed, it is not expected that students will be able to observe all of them.
e) The organization of students' journals should reflect careful, well-documented observation – an essential skill in a science such as astronomy. The journal should have a set format that may include the following: object, date, time, observer's location, sky conditions. Annotated sketches of observed objects and their location in the sky may be included. Questions that arise from each observation should be noted, and adequate class time should be allotted to discussing the format and content of the journal, preparing for out-of-class observations (if any), reviewing the observations, and dealing with questions that arise.

f) If the observations of the phases of the moon are started at the first quarter, the initial observations could be made during class time. This provides the teacher with the opportunity to supervise the recording of these initial observations in students' journals.

g) Students can be introduced to the appearance of the night sky through a properly supervised "star night" at school or as part of an excursion to an outdoor education centre. Alternatively, they can be given simple, specific instructions in school on the use of a simple sky chart and later carry out an evening assignment at their convenience. Students might also visit a planetarium to view an effective simulation of the night sky.

h) Some activities involving the moon and all activities involving the sun can be carried out during the day.

i) In addition to metric units such as the kilometre and megametre astronomers make use of the *astronomical unit* (AU), that is, the average distance between the earth and the sun, and the *light year* (LY), that is, the distance travelled by light in one year. It should be noted, however, that measurement is not a major part of this unit. In activity 2g two different scales may be used, one for distances and another for diameters. If the sun is represented by an orange, however, the same scale can be used, and the model will fit into an average schoolyard.

j) Astronomy has developed rapidly in recent years, and students should realize that some information (e.g., that on the number of satellites of the giant planets) found in secondary sources may be out of date. The science department and the school library should seek to maintain up-to-date reference material on astronomy.

k) Much useful information on current events and developments in astronomy can be obtained from local science museums, planetariums, newspapers, magazines, and certain television and video programs.

l) The intended purpose of activity 2i is to develop good reading skills and the ability to understand and interpret the print medium. Teachers may wish to supplement the print material, however, with audio or video material.

m) Activities 2i and 2j provide oppportunities for developing language skills through the study of science. The emphasis in these activities, however, is on language as a means of conveying information rather than on language as literature.

n) Appropriate newspaper or magazine articles for activity 2j may be chosen by the teacher or by students. In the latter case students should be encouraged to accumulate a file of articles about the chosen topic several weeks in advance of the teaching of the astronomy unit, if possible.

Optional Unit 2

Minerals and Mining

Time: 15 hours

Much of the wealth of both Canada and Ontario is based on our mineral resources and on the mining industry. Thousands of people are employed by mining and mining-related companies. Nevertheless, many people know very little about how minerals are mined and what kinds of jobs exist in the mining industry. This unit will give students some basic information about this important industry and help them to appreciate its importance to our country. Some aspects of this unit may be covered in the geography program. If this optional unit is selected, co-operative planning should take place between the science and geography departments to avoid unnecessary overlap within the two programs.

This unit may be divided into topics such as the following:

- Rocks and minerals
- Mineral exploration
- Mining methods and purification processes
- Mining and the Canadian economy

1. Objectives

Attitudes. Students will be encouraged to develop:

a) an appreciation of the great wealth of Canadian mineral resources;

b) an interest in the importance of mining to the Canadian economy (3b);

c) a respect for people who work in the mining industry and an interest in the kinds of employment involved (4b, 8d).

Skills. Students will have the opportunity to develop skill in:

a) inferring, on the basis of simulations, the processes involved in exploring for and purifying minerals (2a-2c, 2e-2g);
b) following instructions and manipulating materials in order to simulate mining processes (2a-2c, 2e-2g);
c) observing the physical properties of rocks and minerals (2h);
d) classifying some common rocks and minerals (2h);
e) collecting and interpreting data from experiments;
f) reading maps (2d);
g) reading a compass (2d);
h) using the library resource centre to find out about uses for minerals (3, 5c).

Knowledge. Students will be expected to:

a) describe the processes involved in exploring for minerals and extracting and purifying metals (2a-2g);
b) state the differences between rocks and minerals (2h);
c) list the physical properties that are used to identify minerals and rocks (2h, 8a);
d) describe the possible processes by which rocks are formed (8d);
e) describe several different jobs in the mining industry (8d);
f) explain how the local economy is directly or indirectly related to the mining industry (4a, 8b);
g) locate precisely on a map the mines in a given region of Ontario;
h) name some uses for a number of important minerals mined in Canada;
i) list some of the environmental effects that can be caused by various mining processes (4a).

2. Student Activities

Students are to:

*a) simulate a magnetic survey by using a stud finder to find iron objects buried in various positions in a box of sand and attach strings to the box to represent meridians of longitude and parallels of latitude;
b) simulate an electromagnetic survey by comparing the reception of radio signals while walking towards a filing cabinet;
*c) simulate diamond drilling by using play dough of different colours to represent ore bodies that are hidden under the sand and by "drilling" with plastic straws or thermometer casings to obtain "drill cores";
*d) stake a miniature claim near the school and draw a site plan with the help of a compass;
e) simulate the concentration of a mineral by devising one or more methods of separating the contents of a pencil sharpener into a "concentrate" of wood shavings and a "concentrate" of graphite dust;
f) simulate the flotation process by sprinkling some ground-up glitter mineral on tap water in a 100 mL beaker, adding detergent, and stirring gently;
g) add suntan lotion to 100 mL of cold tap water in a beaker, sprinkle glitter on the surface and stir, use an aquarium pump to bubble air through the mixture, and devise a method to remove the glitter from the froth;
*h) examine minerals and rocks and classify them according to their physical properties.

3. Applications

a) Geologists use their knowledge of the physical properties of rocks and minerals to identify minerals that are needed by industry.
b) The extraction and refining of minerals are the basis of some of Canada's most important industries.

Note: Students should be able to identify specific uses for at least six metallic minerals (e.g., iron, copper, nickel, lead, zinc, aluminum, chromium, gold, silver, platinum) and at least five non-metallic minerals (e.g., salt, gypsum, limestone, clay, sand, asbestos, diamond).

4. Societal Implications

a) Mining provides many economic benefits; however, the purifying and refining of minerals often pollute the air and water near the plant.
b) Many opportunities for employment are available in the mining industry.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work (e.g., the magnetic survey in activity 2a);
b) records of the observed properties of rocks and minerals;
c) lists of metallic and non-metallic minerals and their uses.

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* See the subsection entitled "Student Activities" on page 6.

6. Safety Considerations

Students should be informed of the safety precautions that must be observed when they are testing the particular rocks and minerals selected for observation.

7. Possible Extensions

Some students might:

a) build models of the various mining methods dealt with in this unit;
b) study some of the chemical properties used for identifying minerals;
c) build a model of a reverberatory furnace used in smelting;
d) simulate a method of refining ore (e.g., electroplating brass with copper);
e) investigate how the rate of cooling affects the growth of crystals.

8. Some Teaching Strategies

a) Students should tabulate the various physical properties of minerals and keep the tables for use in identifying minerals.
b) Local representatives of the mining industry can be invited to talk to the class.
c) A class discussion of the economic and environmental advantages and disadvantages of the different methods of mining can be conducted.
d) Students can participate in field trips to quarries, different kinds of mines, and places of geological interest.

Optional Unit 3

Continuity

Time: 15 hours

Heredity and environment help to determine an individual's appearance, health, and character. A study of heredity will assist students to understand how they came to be as they are. Moreover, as genetic research rapidly expands its frontiers, students should be aware of some of the issues and controversies surrounding such research. In this unit students will study the mechanisms that govern heredity for all organisms, focusing particularly on human heredity.

This unit may be divided into topics such as the following:

- Variation in a species
- Meiosis
- Mendelian genetics
- Human genetics

1. Objectives

Attitudes. Students will be encouraged to develop:

a) curiosity about the mechanisms of heredity;
b) an interest in the interaction of heredity and the environment in determining an individual's appearance (3, 4c, 4d);
c) an appreciation for the contribution of both parents to their offspring (3a, 3b).

Skills. Students will have the opportunity to develop skill in:

a) deciding from suitable evidence whether or not a characteristic is inherited (2a);
b) making a pedigree for a single trait (2b, 2c);
c) interpreting pedigrees for a single trait (2b, 2c);
d) preparing a chart to determine the genotype and phenotype of offspring for one trait at a time (2c, 2d);

e) preparing a chart to determine the genotype and phenotype of offspring for sex-linked traits such as colour blindness (2e).

Knowledge. Students will be expected to:

a) describe the meaning of the following terms: trait, chromosome, gene, genotype, phenotype, dominant, recessive, meiosis, mitosis, sex chromosome, gamete, zygote;
b) given suitable data (the "n" or "2n" number), state the number of chromosomes in the normal body cells and gametes of an individual and in the fertilized egg of the species;
c) explain how the cells that result from meiosis differ from those that result from mitosis;
d) state two inherited human traits, identifying the dominant and recessive expressions of each (2c).

2. Student Activities

Students are to:

*a) observe variation in several members of the same species (e.g., maize, fruit flies, humans);
*b) investigate the continuation of one or two traits within a family (e.g., by preparing a pedigree);
*c) investigate several single-gene-pair human traits (e.g., earlobe shape, tongue rolling);
d) investigate Mendel's pea-plant experiments by preparing a chart of one or more of his crosses;
*e) complete exercises involving single-gene pairs to predict genotypes and phenotypes (8d).

3. Applications

a) Some characteristics of human offspring can be predicted from a knowledge of parents' traits.
b) An analysis of fetal cells can detect or predict certain genetic diseases or abnormalities before a child is born and allow parents to prepare for any necessary medical treatment.
c) The selective breeding of plants and animals permits the most desirable characteristics to be expressed in future generations.

4. Societal Implications

a) The possibility of manipulating the genes of organisms raises many ethical and legal questions.
b) Genetic analysis can become the basis of decisions in law.
c) The genetic control of pests and genetic improvement in food production in the next few years could alter established economic relationships.
d) Animals that are bred for specific characteristics such as food production, appearance, speed, and height do not tend to be as adaptable to changes in the environment.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) records of observations of variation in a species;
b) charts to compare the genotype and phenotype of offspring;
c) reports on the inheritance of simple human characteristics.

6. Safety Considerations

PTC (phenylthiocarbamide) paper or solution should not be used for taste tests.

7. Possible Extensions

Some students might:

a) investigate simple dihybrid crosses;
b) investigate the role of DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) in the synthesis of proteins and enzymes;
c) investigate asexual and sexual reproduction in plants and animals;
d) investigate the determination of sex in various species.

8. Some Teaching Suggestions

a) Terminology and the chemistry of life processes should not be overemphasized in this unit.
b) The basic structure of a cell should be reviewed in this unit.
c) Photographs and slides of actual human karyotypes can be helpful.
d) Phenotypic ratios of 3:1 can be obtained from several laboratory exercises with living specimens (e.g., maize, tomato plants, fruit flies, tobacco).
e) The pedigree of some famous plant or animal can be presented as an example of productive, selective breeding.
f) The teacher should ensure that students respect one another's feelings and sensitivities and do not in any way cause each other embarrassment regarding human traits.

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* See the subsection entitled "Student Activities" on page 6.

Optional Unit 4

Metals

Time: 15 hours

A knowledge of chemistry and physics provides scientists with a wide variety of techniques for examining materials and understanding their properties. This unit will help students understand the properties of common metals. An alternate unit on the chemistry and physics of home products may be substituted for this unit. However, if this is done, new objectives and activities parallel to those outlined below must be developed.

This unit may be divided into topics such as the following:

- The nature of metals
- Iron and steel
- The chemical and physical properties of metals
- The protection of metals against corrosion

1. Objectives

Attitudes. Students will be encouraged to develop:

a) curiosity about the characteristics of many common metals;
b) an interest in methods of changing the properties of metals (2c, 2e).

Skills. Students will have the opportunity to develop skill in:

a) organizing and interpreting data on the effect of heat on steel (2b, 2c, 2e);
b) handling corrosive liquids (2a, 2e, 2f);
c) forming hypotheses to explain some properties of different metals (2b, 2d);
d) using a control when observing the effect of zinc and magnesium during the corrosion of steel (2f);
e) demonstrating the effect of tempering on steel and the resultant changes in the physical properties of steel (2b, 2c, 2e).

Knowledge. Students will be expected to:

a) state that steel crystals can be altered and that the alteration changes the properties of the steel, thereby allowing the metal to be used for many different purposes (2b, 2c, 2e, 8f);
b) explain how steel is tempered and how tempering changes the crystalline structure and properties of steel (2b, 2c);
c) state that most metals other than steel have only one crystalline structure (2b, 8f);
d) explain that the carbon content of steel affects both its chemical properties and its resistance to corrosion (2e);
e) list the techniques used to protect low-carbon steel from corrosion and explain that stainless steel resists corrosion (2f);
f) describe ways of demonstrating the chemical activity of different metals and explain how this activity is used in the electrolytic protection of steel (2f, 8c).

2. Student Activities

Students are to:

*a) treat a variety of metal strips (including galvanized steel and metal from a tin can) with dilute hydrochloric acid, examine the treated metals (before and after treating) with a hand lens or microscope, and sketch the crystals, noting the changes in patterns (6a, 8a-8d);
*b) heat a thin safety razor to red hot with a Bunsen burner flame in a darkened room, allow it to cool, and observe the flash (recalescence) as the steel cools and the crystalline structure changes; repeat the activity using strips of copper or nickel (6c, 8f);
c) (i) heat a large safety pin to red hot in a Bunsen burner flame and immediately quench the pin in cold water; then attempt to etch a glass plate with the pin and to bend the pin with pliers; (ii) repeat the activity, but this time remove the pin from the flame slowly, cool it in the air, and then again try to etch the glass and bend the pin; (iii) repeat the activity using a straightened paper clip (6c);
d) clamp a strip of metal with one end over a Bunsen burner flame and with a small cube of paraffin on the other end and note the time it takes to melt the paraffin; repeat the activity using a variety of metals and alloys (6c);
e) (i) treat a strip of stainless steel and a strip of low-carbon steel with concentrated nitric acid, etch each strip with a sharp steel point, and again treat it with the acid; (ii) repeat this entire process with strips that have been strongly heated and then cooled; (iii) heat another similar pair of metal strips and note the various colour changes that indicate different metal tempers; (iv) coat another pair of strips with oil and note the effect of acid on the metals (6, 8d);

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* See the subsection entitled "Student Activities" on page 6.

*f) sand three large steel nails, fasten a thin piece of magnesium metal around the first nail and a thin strip of zinc ribbon around the second, place each nail in a separate test tube of dilute sulphuric acid and shake the three tubes gently every three minutes during a fifteen-minute interval, and then leave the test tubes standing overnight (6a).

3. Applications

a) The ability of steel to assume different crystalline structures and to form many alloys gives rise to different kinds of steel with different strengths and properties. This allows steel to have many specialized uses (e.g., for auto parts, tools, power shovels, knives, razors).
b) When a metal is chosen for a particular application, heat conductivity is one consideration. For example, car radiators, soldering irons, and water-heater coils need a metal with a high conductivity, whereas window sashes should have a low conductivity.
c) In many applications where the natural oxide protective covering of metal will wear off, an electrolytic process may be used to protect the metal. For example, the galvanizing of iron with zinc slows the rate of corrosion and allows its use in the manufacture of garbage cans, roofing metals, iron pipes, and pails.

4. Societal Implications

a) Our highly developed technological society depends on our knowledge of the properties of many metals, especially the different kinds of steel.
b) Metals may be weakened by heat and corrosion that result from the action of the weather, air, water, and chemical substances. The protection of metal structures such as automobiles, bridges, ships, and trains involves enormous expense and labour.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) laboratory work (e.g., their sketching of the crystal patterns of metals);
b) experimental records and notes on the effect of heat on steel;
c) formation of hypotheses to explain experimental results.

6. Safety Considerations

a) Students must wear protective eyewear when they handle acids or heat and bend metals.
b) Safe procedures for the handling of corrosive liquids must be followed.
c) Hot metals and metals treated with acids should be handled with care. A hot metal must not be placed in an acid.

7. Possible Extensions

Some students might:

a) investigate the magnetic properties and the hardness of steel;
b) investigate means of magnetizing non-magnetic steel and read about ferromagnetic domains;
c) conduct a library search on the making of alloy steels and their properties and uses.

8. Some Teaching Suggestions

a) Students can be encouraged to list some of the common metals they use and the properties of these metals.
b) Since 90 per cent of all metal used by society contains iron, students should have an understanding of the properties of ferrous metals.
c) Tin cans containing fruit juices, fruit, vegetables, and pop can be examined and used for the experiments with crystals and corrosion.
d) Carbon steel and tin react with hydrochloric acid. When steel coated with tin is exposed to hydrochloric acid, the crystals are etched because the metal along the boundaries of the crystals reacts faster than the crystals. Tin and zinc have large crystals, which can be readily seen with a magnifier.
e) Hot metals and metals treated with acids should be handled with special care. Students should be familiar with accident prevention and procedures in the event of an accident.
f) Recalescence occurs in steel and not in other metals because steel undergoes a unique type of crystalline change.
g) In activity 2d, the metal strips should be heated by means of a constant Bunsen burner flame, or they may be replaced with a conductometer.

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* See the subsection entitled "Student Activities" on page 6.

Optional Unit 5

Terrestrial and Aquatic Ecosystems

Time: 15 hours

The intent of this unit is to have students extend their knowledge of the basic principles of ecology outlined in core unit 1 of this course and to consider their practical applications. Since aquariums, terrariums, gardens, and house plants will be familiar to many students, they can be used to illustrate the functioning of larger ecosystems.

This unit may be divided into topics such as the following:

- Aquatic ecosystems
- Terrestrial ecosystems
- A model ecosystem

1. Objectives

Attitudes. Students will be encouraged to develop:

a) a respect for the delicate balances that exist in an ecosystem (2c, 4a, 4c);
b) a questioning approach towards interactions in an ecosystem (2d, 3, 4);
c) care in handling plants and animals.

Skills. Students will have the opportunity to develop skill in:

a) setting up a model ecosystem, such as an aquarium or a terrarium (2a, 2b);
b) measuring abiotic factors in an ecosystem (2b);
c) observing the biotic factors in an ecosystem (2d);
d) inferring the relationships that exist in an ecosystem (2d).

Knowledge. Students will be expected to:

a) recall the meaning of the term *ecosystem* and apply it to an aquatic and terrestrial situation;
b) explain the meaning of the following terms and give examples of each term in a typical aquatic and terrestrial ecosystem: biotic, abiotic, food chain, food web;
c) list the basic similarities and differences between aquatic and terrestrial ecosystems;
d) explain similarities and differences between closed and open ecosystems;
e) describe how to establish a model ecosystem;
f) describe the ecological relationships in a model ecosystem.

2. Student Activities

Students are to:

*a) establish a model aquatic *and* terrestrial ecosystem, such as a tropical-fish aquarium, pond-water aquarium, terrarium, or garden (5a, 6a, 6c, 6d, 8a, 8d);
*b) determine the following: (i) plants that will grow in the ecosystem; (ii) animals that are compatible with the plants; (iii) the abiotic requirements of the plants and animals, such as pH, temperature, soil conditions, and moisture (5b, 6b, 6d);
*c) maintain the model over a period of time by adjusting the various abiotic factors as required (5a, 6e);
*d) observe and record the changes that take place over a period of time (5c).

3. Applications

a) The management of forests involves using the principles of ecology.
b) High crop yields on a farm result from modifying an ecosystem.
c) Aquaculture techniques are used in many areas to harvest marine and freshwater products (e.g., seaweed, oysters).

4. Societal Implications

a) Ecosystems are sensitive to environmental changes and can easily be damaged or destroyed (e.g., by acid rain).
b) Natural ecosystems are a source of much pleasure and recreation to people who enjoy nature and such activities as camping, hiking, and canoeing.
c) The poor management of farm soils may result in the loss of good agricultural land.

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* See the subsection entitled "Student Activities" on page 6.

5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) application of practical techniques for setting up and maintaining a model ecosystem;
b) measuring of abiotic factors in an ecosystem;
c) records of observations of the biotic components of an ecosystem.

6. Some Safety Considerations

a) Approved electrical components should be used for aquariums.
b) The reagents used for water or soil testing should not come in contact with the skin or clothing.
c) Teachers should ask students to inform them if they have any allergies to plant material.
d) Students should follow appropriate safety procedures when handling the chemicals used in gardening.
e) Power to aquariums and terrariums should be shut off before maintenance procedures are started.

7. Possible Extensions

Some students might:

a) investigate and build additional model ecosystems;
b) conduct soil testing using nutrient test kits to determine fertilizer requirements.

8. Some Teaching Suggestions

a) Students should work in small groups to set up various model ecosystems.
b) Students should be encouraged to visit pet shops to see the various ways in which aquariums can be set up.
c) A pond-water ecosystem can be set up most easily in late spring or early fall.
d) For a model ecosystem that requires plants, the teacher should start or obtain plants in advance so that they will be ready when needed.
e) Students can visit local nurseries, farms, botanical gardens, pet stores, conservation authorities, natural ponds, or streams to view examples of various ecosystems.

Optional Unit 6

Locally Designed Unit

Time: 15 hours

This unit is the same for the Grade 10 general-level science course as optional unit 4, "Locally Designed Unit", is for the Grade 9 general-level course. A different set of topics from those selected in the previous grade should, of course, be chosen for this course.

Appendixes

Appendixes

A. Science Courses and Their Course Codes
B. The Table of Contents of Part 1

Appendix A

Science Courses and Their Course Codes

The secondary school guideline courses in science authorized under this document have the following course codes:

Science, Grade 9, Basic Level	SNC1B
Science, Grade 9, General Level	SNC1G
Science, Grade 9, Advanced Level	SNC1A
Science, Grade 10, Basic Level	SNC2B
Environmental Science, Grade 10, General Level	SEN2G
Science, Grade 10, General Level	SNC2G
Environmental Science, Grade 10, Advanced Level	SEN2A
Science, Grade 10, Advanced Level	SNC2A
Science, Grade 11, Basic Level	SNC3B
Applied Biology, Grade 11, General Level	SBA3G
Applied Chemistry, Grade 11, General Level	SCA3G
Environmental Science, Grade 11, General Level	SEN3G
Biology, Grade 11, Advanced Level	SBI3A
Chemistry, Grade 11, Advanced Level	SCH3A
Science, Grade 12, Basic Level	SNC4B
Environmental Science, Grade 12, General Level	SEN4G
Geology, Grade 12, General Level	SGE4G
Applied Physics, Grade 12, General Level	SPA4G
Environmental Science, Grade 12, Advanced Level	SEN4A
Geology, Grade 12, Advanced Level	SGE4A
Physics, Grade 12, Advanced Level	SPH4A
Technological Science, Grade 12, General Level	STE4G
Biology, OAC	SBI0A
Chemistry, OAC	SCH0A
Physics, OAC	SPH0A
Science in Society, OAC	SSO0A

The following general rules govern science course codes:

- All science course codes begin with an **S.**
- **SNC** identifies a course that has only the name "Science".
- Where one word other than "Science" describes the course, the first two letters of that word follow the **S** (e.g., **SBI** means "Science, Biology" or simply "Biology"; **SEN** means "Science, Environmental" or "Environmental Science").
- Where two words other than "Science" describe the course, the initial letters of those words are used (e.g., **SCA** means "Science, Chemistry Applied" or simply "Applied Chemistry").
- The fourth character in the course code, **1**, **2**, **3**, **4**, or **0**, represents Grade 9, 10, 11, 12, or an OAC respectively.
- The fifth character represents the level of difficulty: **B** for basic, **G** for general, or **A** for advanced.

For further information on course codes, refer to the *Manual for the Common Course Code* (Toronto: Ministry of Education, Ontario, 1986).

Appendix B

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Appendixes

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